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ABSTRACT

Designed to examine the nature of ideas that students hold about specific scientific concepts and to investigate modes of instruction that would effectively help them gain an accurate understanding of their world, this study focused on students' conceptions of ecological concepts and the influence of field instruction strategies on students' understanding and retention of these concepts. An experiential 7-day field program served as the learning strategy for three independent groups of secondary students. Students responded to a specially designed instrument, Student Ecology Assessment (SEA), prior to, during, and 4 weeks after the field program. Background data, instructional emphasis ratings, SEA concept subscores and total scores were entered into multiple regression analyses. All groups exhibited significant posttest gains (at the .001 level) and showed evidence of retention of the targeted concepts. Gains in scores in the major concept strands were positively related to the instructional emphasis given to those areas. The effectiveness of the field program was apparent in that specific concepts that were emphasized were learned and retained. The mastery approach of learning in a field setting proved to be successful. A 100-item bibiligraphy and 118 data tables are included. (ML)

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THE EFFECT OF FIELD-BASED LEARNING EXPERIENCES ON STUDENTS' UNDERSTANDING OF SELECTED ECOLOGICAL CONCEPTS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Marylin Lisowski, B.A.,M.A.

* * * * *

The Ohio State University

1987

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SE 047 962

DEDICATION

To my dear Family

my Mother, Godmother, Sisters, and Brothers

ACKNOWLEDGEMENTS

The basic principles of ecology that speak of elements of interconnectiveness and interdependencies were clearly operative in this study. The efforts and talents of many were responsible for the sustenance and completion of this project.

Primarily, I thank God for this earth, education, and science and for this program that assisted in preparing me to meet the challenges and to contribute to the mission of each. I also thank God for all the people who have inspired and contributed to this study and my program. To the greatest treasure in my life, my mother Harriet Lisowski, I express my deepest appreciation for the love, solicitude, and hope that she has constantly lavished on me. Her unparalleled talents, resiliency, faith, and strength are a source of pride and wonder to me. To my dearest godmother, Josephine Janus, I offer my gratitude, respect, and affection for her unlimited graciousness, resourcefulness, prayers, and for her tremendous example. I thank and love my sisters, Marya and Rosemary, for their constant concern, conversation, humor, and vibrant friendship. They are

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I extend my greatest respect and admiration for the exemplary mentors who have been luminary models of excellence for me throughout my program. I am indebted to my advisor, Dr. John Disinger, for not only introducing me to the possibilities of learning in, about, and for the environment, but for so patiently and graciously guiding me in my career and through my program. To Dr. Robert Howe, whose phenomenal capabilities, dedication, and accomplishments consistently radiate excellence, paramount levels of appreciation and acclaim are due. The unlimited time, talents, and guidance that he provided in creating, nurturing, and refining my learnings and studies have indeed been the hallmark of my entire program. My respect and admiration are expressed to my committee member and guide, Dr. Rosanne Fortner, for her all her encouragement and personal inspiration. To Dr. Russell Utgard, my gratitude extends beyond the science I have learned from him in the class and field to what I have learned from him as a quality person and educator. I acknowledge Dr. Garry McKenzie for his many accomplishments, his varied expressions of competence, and for all the motivation and gentle guidance that he has provided for me throughout my professional and scholastic

career. To my two successful brothers in academia, Skip and Paul, I am so thankful and proud of the professional triumphs that each has accomplished and for the standards of excellence that each has modeled so sensitively and positively for me. Their proficiences and overall brilliance have been a source of pride as well a motivating factor in my pursuit of higher education.

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CHAPTER I

INTRODUCTION

IMPORTANCE OF THE STUDY

The dynamic nature of science is well portrayed through consideration of the evolutionary growth of its basic ideas and premises as well as of its revolutionary breakthroughs and discoveries. Change is not only a characteristic of science but also is evident in perceptions and explanations of how learning about the sciences occurs. Currently, attention is being directed to the conceptual understandings of students prior to and during, as well as after, formal instruction. A constructivist view maintains that a learner's prior knowledge is the most important ingredient in the process of meaningful learning (Ausubel, 1968; Wittrock, 1974; Osbourne and Wittrock, 1983; Driver, 1983; Clough, 1985).

Just as we can no longer be content to accept inchoate medieval explanations of the universe, so too we can no longer be satisfied with a "tabula rasa" perception of the learner and a simplistic monomodal approach to instruction. Recent developments and insights into the nature of human

cognitive processing have the potential to assist educators in providing quality learning opportunities for today's youth. Models of how youth process information need to be examined and alternative instructional strategies which assist students in this process need to be investigated.

With perspectives gleaned from the fields of cognitive science, constructivist thought, and experiential learning theories, this study was designed to explore the nature of ideas and beliefs which students hold about specific scientific phenomena and to investigate instructional strategies that are designed to help them gain an accurate understanding of their world.

A model which focuses on three dimensions of the learning process was employed in the investigation. Areas of concern included: 1) the learners (exploring their understanding of selected concepts in ecology); 2) the learnings (identifying core biological concepts related to ecology and feeding relationships); and 3) the learning environment (examining the effectiveness of field instruction strategies on concept understanding and retention). An overview and a rationale for considering these areas of emphases follow.

THE LEARNER

Recent research has indicated that students' understandings of natural phenomena differ in fundamental ways from

the explanations given about them in science courses (Smith, 1986). Current research findings suggest that the alternative conceptions that students hold can influence observations, color explanations, and affect their later learnings. Given this tenet, a model of conceptual change that provides for the unlearning of misconceptions has been heralded as being the "most determinative" factor for students' acquisition and retention of subject matter knowledge (Ausubel, 1968). If the teaching of science is to help pupils develop theoretical understandings and workable models to interpret phenomena in accordance with the nature of science, provisions for the ideas and beliefs which students already hold must be made (Driver, 1983; Clough, 1985). If learning is viewed as a process of conceptual change, it cannot occur simply through an addition of new bits of information, but must involve the interaction of new knowledge with existing knowledge in order that the new may be reconciled with the existing (Hewson and Hewson, 1983). The established tenets of the scientific community and the existing beliefs and conceptions of students should both be considered in designing and implementing instructional programs.

Research has shown that students experience considerable difficulties in understanding scientific principles and processes because of preset misconceptions and beliefs

(Anderson and Smith, 1982; Anderson, and Smith, 1986; Driver, 1983; Helm and Novak, 1983; Stewart, 1983). It has been noted that these misconceptions influence student behaviors and interpretations of instruction and interfere with intended learnings. Much of this research has been done on aspects of physical science, while applications to the biological sciences have been limited. This study has been designed to contribute to the findings which focus on the biological sciences through a specific emphasis on ecological concepts.

THE LEARNINGS

Familiarity with the basic principles of ecology has been offered as having the potential to influence one's world view, to clarify relationships that human beings have to the natural world, and to help in the recognition of the constraints that nature places on human activities (Ehrlich, 1986). These goals concur with current recommendations for the direction of science education in the 1980s (Yager, 1984). However, instruction in ecological concepts has proved to be no facile, simplistic undertaking. Ecology has been recognized to be problematic because of its consideration of interrelationships among concepts of widely disparate degrees of concreteness and abstractness, with a preponderance of the latter. Thus instruction of ecological concepts presents a challenge to teachers (Garb, Fisher, Faletti, 1985).

Concepts related to feeding relationships were targeted for special emphasis in this study. The concept of feeding relationships was ranked highly by biology teachers as an area of critical importance in the study of biology (Finley, Stewart, and Yarrow, 1982). Its centrality in understanding other complex ecological principles also has been noted (Novak, 1976). Investigation of this dimension of ecology was also selected because it has been indicated that feeding relationships are difficult for students to understand (Johnstone and Mahmoud, 1980). Thus, approaches for effective instruction in this area need to be explored.

THE LEARNING ENVIRONMENT

Field instruction was selected as the focal instructional strategy in this study. Theoretical, philosophical, empirical, and popular support for a field approach to learning, although not voluminous, exists. Piagetian theory advocates that provisions for direct experiential, relational opportunities assist in and enhance learning. Novak (1986) contends that direct experiences with real objects and processes can give form and meaning to primary concepts and facilitate differentiation and application to more complex concepts. With science teachers, field instruction has evidenced popular support and has been ranked as being an important and valuable method for teaching science, yet actual implementation rates are quite low (Ateyeo, 1939;

Fowler, 1958; Schwaab, 1975; Mason, 1976; Hurford, 1977; Falk and Balling, 1978; Muse, 1982). For example, in a 1983 International Science Study, 65 percent of the responding students indicated that they had never engaged in fieldwork outside of the classroom (Jacobson and Doran, 1986). Discrepancies are apparent between teachers' belief in and actual use of this technique. If field instruction is to be offered and used more extensively, research must support the premise that particular science concepts and processes, such as those related to ecology, can be learned effectively in a direct experience field setting.

STATEMENT OF PROBLEM

It was the intent of this study to obtain information on students' conceptions of selected biological phenomena within the domain of ecology and then to investigate the influence of field instruction strategies on students' understanding and retention of the targeted concepts. The following questions form the framework of the study:

1. What are students' conceptions of selected ecological concepts?
2. Do field-based activities assist in the clarification of these concepts?
3. Do students retain the concepts learned after direct involvement in field programs?

4. How are background variables (i.e. academic standing, sex, attitudes, science interests and involvements, learning preference, and travel experience) related to student knowledge and learning gains?
5. What is the relationship between instructional emphasis and students' science achievement gains?

HYPOTHESES

Appropriate statistics were used to test for the acceptance or rejection of the following null hypotheses:

1. There are no significant changes in students' understandings of ecological concepts after field instruction strategies.
2. There is no significant difference in the degree of retention of concepts evidenced after field exposure.
3. There are no significant relationships between student background variables and gains in understandings of concepts.
4. There is no significant relationship between instructional emphasis and students' science achievement gains.

DEFINITIONS OF TERMS

Conceptions
: units of information which are linked together.

Concept mapping
: process that involves identification of concepts in a body of materials and the organization of the concepts into a hierachial arrangement.

Conceptual bridging
: process of linking abstract concepts with meaningful common experiences.

Constructivism
: theory which focuses on the acquisition, understanding, and application of bodies of conceptual structures of accepted public knowledge and emphasizes interaction of existing knowledge with new knowledge.

Ecology
: specialized branch of the biological sciences which focuses on relationships between living things and their environment.

Extended excursions
: school sponsored educational trips lasting longer than a day, usually a week.

Feeding relationships
: phenomena which take into account the flow of energy and circulation of materials through the process of eating or being eaten.

Field instruction
: on-site activities/experiences in which students are directly involved.

Higher-order cognitive items
: questions which demand application, analysis, synthesis, and/or evaluation.

Integration
: process of incorporating new concepts with existing conceptions, or different existing conceptions with each other.

Knowledge items
: test situations that emphasize remembrance, either by recognition or recall of ideas, materials, or phenomena.

Misconceptions
: representations of systems of explanation which are conceptually incorrect.

Preexisting conceptions
: informal knowledge which constitutes the students' belief system about the world and how it works.

Scientific conceptions
: accurate explanations of scientific phenomena.

Structured field programs
: clearly defined programs with student oriented goals, program objectives, and specified procedures, including pretrip and posttrip sessions.

ASSUMPTIONS

The following assumptions underlie the study:

1. The concept instrument and the student background form designed for this study were reliable and valid means

for making the measurements for which they were designed and used.

2. Students completed the instruments conscientiously.
3. The concepts targeted for investigation are fundamental to learnings within the field of ecology and are basic for students' future learnings in science.
4. The field programs examined were representative of educational offerings in this realm.
5. Teachers' reports of concepts emphasized and strategies employed during the field program provide an accurate description of the actual program.

DELIMITATIONS

The delimitations of this study were as follows:

1. The participating schools were limited to secondary schools that had marine science programs that included field instruction components.
2. The study was limited to three different marine science programs.
3. Field programs were limited to those that had specified program objectives, a series of pretrip and posttrip sessions, and required student projects and/or activities.
4. Testing was limited to assessments of changes in concept understandings, and not of skill areas or of attitudes changes.

5. Testing focused on understandings of concepts in ecology.
6. Data were obtained solely from responses to paper and pencil instruments.

LIMITATIONS

The limitations of this study include:

1. The use of specific grade levels, thereby preventing generalizability of the results to other grade levels.
2. Restrictions with the sampling populations because of the limited numbers of schools that have field programs.
3. A concentration on selected ecological concepts which comprises only one area of instruction in the sciences.
4. A focus on one type of field experience, the structured extended excursion, thus limiting generalizability of the results to other types of field programs.

OVERVIEW

The dissertation includes five chapters.

Chapter One provides a rationale for the study; problem statements; hypotheses; definitions; assumptions; delimitations; and limitations.

Chapter Two contains a review of the literature and is reported in three sections. These focus on: field instruction in the sciences; concept learning in the biological sciences; and student characteristics and science achievement.

Chapter Three consists of the research design and procedures. They address the areas of: overall design; population; instrumentation; data collection procedures; and statistical analysis.

Chapter Four reviews the study's results. Five sections are reported and include: descriptive statistics; correlations; regressions; percentages of gain; and hypotheses.

Chapter Five contains a summary, conclusions, and recommendations.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter considers literature related to the three dimensions of the learning process that this study investigated: the learners; the learnings; and the learning environment. Specific domains within these general areas that are directly pertinent to the nature and intent of this study were targeted for emphasis. These included: 1) empirical studies that focused on the cognitive dimension of learning science through field instruction techniques; 2) studies which investigated conceptual development in the biological sciences; and 3) meta-analyses studies of student characteristics and science achievement.

FIELD INSTRUCTION IN THE SCIENCES - THE LEARNING ENVIRONMENT

The field excursion is not an innovation of this era. Attempts to instruct in the field have been charted through the centuries up until and including the present time. Socrates and Aristotle led their followers directly to the natural environment for observation and discussion about

nature; expressions of similar efforts currently are being evidenced. Even though general sentiment is in accordance with the value of learning science in a direct environmental setting, actual implementation attempts of field programs are limited. In a comparable manner, a considerable amount of descriptive literature and position statements exist on learning in the outdoors, but experimental studies that investigate its merits are sparse.

This review includes the limited sample of reported experimental studies which primarily focused on field instruction in the sciences as it relates to aspects of students' cognitive development. Summaries of the studies are presented in chronological order.

Schellhammer (1935) investigated knowledge gains of two groups of high school biology students. His study covered a period of one year. Experimental and control groups were established, with the experimental group participating in a field excursion. Posttests were given to both groups and knowledge gains were significant with only the experimental group. The groups were reversed (control becoming experimental and vice versa) and a new unit of study was taught following the same procedures. Again, the new group that had the field trip showed more significant gains than the new control group.

The impact of extended excursions was studied by Raths (1936) with students who were taken to the coal fields of West Virginia on a ten-day trip. Students who had participated in the field trip were judged to be superior in their abilities to evaluate tasks related to scientific inquiry when compared to non-trip students.

Fraser (1939) worked with the same group of students as Raths did, but focused on increases in information that trip-students had evidenced. He distinguished knowledge gains from memorized information. Measurements were made of students' abilities to generalize and apply the principles learned. He concluded that the greatest value of learning in the field was skill in knowledge acquisition and application.

Atyeo (1939) conducted a study in which he compared the results obtained from the use of the excursion technique with those of other teaching methods. He showed that with an increase in excursions there was an increase in investigating the phenomena associated with the experience. He demonstrated that the excursion technique is superior to class discussion for teaching material requiring comparisons and knowledge of concrete objects.

When testing the usefulness of field trip guidebooks, outlines, instructional materials, and associated techniques, Evans (1958) found that classes that used the

planned field trip learned more, retained more, and did better on tests than classes that did not participate on field trips.

Testing the effectiveness of field trips in the teaching of college level botany, Kuhnen (1959) found that the groups which were actively involved in field trips showed some, but limited, gain over control groups which were instructed in a laboratory setting.

Benz (1962) conducted an experimental evaluation of field trips for achieving informational gains in a unit on earth science. Four classes of ninth graders (n=109) participated in the study. The experimental groups went on excursions to geologic sites while the control groups remained in the classroom and reviewed the content through slides. Based on pretest and posttest results, Benz concluded that superior pupils tend to profit more from field trips than students with average to less than average ability, but that field trips may contribute to the understanding of scientific principles.

A comparison of two instructional methods, field instruction and the discussion method, was undertaken in a study by Bennett (1963). A unit on ecology was taught by both methods to groups of seventh graders. Bennett found no significant gain from the experimental field treatment over the traditional classroom discussion method but found

the field experience as effective as the discussion technique.

Glenn (1968) probed the effectiveness of learning geology through field experiences. The study involved a comparison of the field technique and the use of color slides in classroom discussion. In none of the comparisons did the field trip group score significantly higher than the group taught with slides.

A similar comparison was made by Goldsbury (1969), who examined the effects on learning from substituting slide-tapes for an actual field experience. Test results indicated that the vicarious experience afforded through the slide-tape presentations proved to be more effective than direct exposure to field trip experiences. However, direct experiences in the field coupled with exposure to slide-tapes in the classroom was found to be a more effective approach.

In research conducted by MacKenzie and White (1982), the effect of fieldwork on retention levels was examined among eighth and ninth graders from Melbourne, Australia. Three groups of students were involved. All treatments had the same general learning program, but differed in the excursion phase of the program. There was an active processing excursion group, a traditional passive excursion group, and a group that did not have field work. Two tests were giv-

en, one on achievement of unit objectives and the other on formation of episodes and the linking of them with other knowledge items. Both tests were given prior to formal instruction, while the posttest was given during the summer holidays just prior to the beginning of the new term. Posttest results indicated that the students who had fieldwork performed better than students who did not have the field component of instruction. Retention was superior in the group that participated in the active excursion program.

To evaluate the effects of field activities on student learning, a study was conducted by Kern and Carpenter (1986) with two sections of a college laboratory course in earth science. One section involved primarily classroom activities that utilized a laboratory manual. Field-oriented activities were employed in the second section. Comparison of the two classes at the conclusion of the term revealed almost identical levels of lower-order learning (recall). However, higher-order skills were demonstrated to a greater degree with the field-oriented section, indicating an enhanced ability to apply the acquired information.

In the meta-analysis conducted by Wise and Okey (1983) on instructional strategies, one category examined was presentation mode. This category included those means of

instruction where the setting was different from a traditional environment. Field instruction was a targeted mode of learning within this category. The mean effect size obtained for cognitive and other (attitudinal, problem solving) outcomes was .26 based on 103 studies. It proved to be more effective than the traditional strategies of learning.

The educational values and benefits of instructional field programs in the sciences have been investigated and studies have explored the possible impacts on students' attitudes, skill attainment, and cognitive development. Research studies of the 60s and 70s primarily focused on the affective domain with emphasis on students' attitudes toward science and natural phenomena. While most field experiences were designed to introduce concepts and/or to extend opportunities for clarifying and exploring these concepts, research investigations were limited in studying these cognitive impacts. Research studies virtually have been non-existent in examining the role of instructional emphasis and/or the effectiveness of a hierarchial approach to concept learning in the field. The key aspect of concept retention after field instruction is another area where research attempts have been lacking. This study was designed to examine these areas that were not focused on previously in the literature and to assess whether complex

concepts could be taught meaningfully in a field setting. For the areas that were investigated related to conceptual development and field instruction strategies, including those reported in this review, the literature does generally suggest that the field instructional approach can be a valid and effective technique for assisting students in their learnings of scientific concepts.

CONCEPT LEARNING IN THE BIOLOGICAL SCIENCES - THE LEARNINGS

Currently, research in science education has been concerned with students' conceptual understandings and mastery of schemes of organized knowledge. Efforts have been directed to investigating the nature of the belief systems that students have prior to instruction and also to exploring the types of strategies that effectively facilitate conceptual development. Much of this research has focused on the physical sciences, while studies related to the biological sciences have been limited. This section reviews those studies that have examined students' understandings of biological concepts.

Students' understandings of concepts related to adaptation and evolution formed the basis of Jungwirth's study with Israeli youth (1975). A representative sample of secondary students (n=1277) responded to one of three forms of the Test on Understanding of the Language of Science. Data

revealed that the students had distorted views of the concepts of adaptation and evolution and that a high percentage could not differentiate factual information from anthropomorphic statements.

In an effort to examine students' prior knowledge of evolution and heredity, Deadman and Kelly (1978) questioned secondary school age males (n=52) before their formal instruction on those units and then re-interviewed the students after a 12 month interval. Virtually all students offered some ideas about why evolution occurred; however, most students demonstrated uncertainty and lack of clarity in their responses. A lack of understanding concerning the source of variation among organisms was evident in the interviews. Explanations of change were given in essentially Lamarckian terms and the boys resorted to expressions of folklore in most of their responses.

Designed to obtain some knowledge of children's beliefs about the topic of inherited characteristics, clinical interviews were conducted with 32 children from grades 1 through 8 in Canada (Kargbo, Hobbs, Erickson, 1980). Students were asked to respond to questions related to five tasks which required them to distinguish between environmental and hereditary characteristics and to use probabilistic thinking in predicting characteristics of offspring. A wide range of beliefs about the nature and mechanism of

inheritance was evident in the students' responses. A considerable number stated that environmentaly-produced traits would be inherited. Younger children were found to be rigid in their thinking and had established patterns for their own theories.

Concepts related to taxonomy and to the identification of animals were explored in a study by Bell (1981). Elementary, secondary, and tertiary students (teacher trainees) were asked to identify from a group of organisms those which they considered were animals. Of the 39 elementary and secondary students interviewed, 35 could not classify correctly all instances of the concept. Responses to the multiple- choice test revealed that misunderstandings were not specific to younger children, for 41 percent of the teacher trainees incorrectly classified at least one of the problem situations.

Based on the notion that the "life concept" is central in any life science course, a study was undertaken to examine Israeli students' conceptions of life (Tamir, Gal-Chappan, Nussinovityz, 1981). Intermediate and junior high school students (n=424) were interviewed individually and were asked to complete classification tasks as well as a questionnaire. It was found that children associate different meanings with the concept of life and that a large proportion of the explanations were scientifically incorrect.

A two-year Planning and Teaching Intermediate Science Study (PTIS) was undertaken for the purpose of using students' misconceptions to analyze classroom behavior of teachers and students and to modify the science program of the schools (Smith & Anderson, 1984). Case studies were conducted on 14 teachers. It was found that teachers exhibited a variety of teaching styles that did not take student misconceptions into account. Student testing also occurred. Student pretest results indicated that misconceptions were abundant. Additional testing efforts revealed that fewer than one quarter of the students learned the concepts that were covered in the classes. Modified materials then were developed to inform teachers about student misconceptions and strategies were suggested for helping students to change. Findings showed that when student problems and misconceptions were identified, learning improved substantially.

A study was conducted in Nigeria to determine some of the misconceptions held by secondary school students with respect to selected ecological concepts covered in a unit of Nigeria's Secondary School Science Program Biology text (Adeniyi, 1985). Students' explanations were obtained by classroom observations, essay test answers, and clinical interviews. The actual coverage of ecology in the designated classes was determined by analyzing the curriculum

content as it was found in classroom instruction, text materials, lesson plans, and teacher examinations on ecology. Data obtained indicated that students possessed several misconceptions and that students were not willing to give up these positions. There appeared to be two sources of the misconceptions: the already existing conceptions of the students and those that resulted from instruction.

Student knowledge of marine science and natural resource principles was investigated in a study by Brody and Koch (1986). Baseline data on Maine's 4th, 8th, and 11th graders were generated from this study. Student responses were classified as being: correct conceptions, missing conceptions, or misconceptions. Although it was found that fourth grade students did understand the basic concepts of food chains and food webs, there was very little growth in knowledge of food chain dynamics in grades 8 and 11. Findings suggested that students' missing conceptions and misconceptions interfered with and/or inhibited new learnings.

Biology students' understandings and misconceptions about the concepts of food chains and ecosystems were investigated in a study by Marek (1986). Student responses were obtained from an essay- type instrument and were classified by degree of their understanding. Of the 58 students tested, only one student (2 percent) had a sound understanding of the concept of food chain, 34 percent of

the students demonstrated partial understanding, 57 percent showed specific misunderstanding, and 7 percent had no response.

In an effort to identify common student misconceptions in biology, Murr (1986) investigated students' understandings of topics related to the animal concept, food webs, gene behavior, and photosynthesis. Testing revealed that the tested high school students had archaic patterns of thought, with several misconceptions present. A semi-guided discovery teaching strategy was employed to focus student attention on the misconceptions. Later testing supported the effectiveness of the instructional approach that took students' misconceptions into account.

Research findings have supported the notion that students' understandings and beliefs about natural phenomena differ in fundamental ways from accepted scientific explanations. Documentation for the existence and tenacity of these alternative frameworks has been increasing substantially in the physical sciences. Attempts to investigate students' conceptual views of biological phenomena, although not as abundant as explorations in the physical sciences, also have been undertaken. These studies have indicated that students do possess conceptual views of science topics prior to instruction and that these prexisting beliefs can affect their learnings. These studies suggest

that if meaningful learning is to occur, it is essential initially to attain some knowledge about children's established belief systems and then to explore the various ways and strategies in which these understandings can be addressed. This challenge necessitates not only the uncovering of students' prior learnings but also includes the implementation of strategies that can effectively exchange and/or extend students' understandings of science. This study focused on biological concepts and specifically ecological concepts for several reasons. Ecology was selected because of its centrality in the scheme of the biological sciences and for reasons related to both teachers' recognition of its importance in the curriculum and to students' expressions of difficulties in learning the concepts.

STUDENT CHARACTERISTICS AND SCIENCE ACHIEVEMENT - THE LEARNERS

Results reported from reviews of research and meta-analyses studies have indicated that antecedents to student achievement have been identified and have consistently accounted for a substantial amount of explained variance. Variables identified in this study which were included in meta-analyses reviews are reported in this section. These include: prior learning and academic ability; attitudes; and sex.

Prior Learning and Academic Ability

A meta-analysis of students' ability and science learning was conducted by Boulanger in 1980. His review included studies from a 16 year period and focused on students from the sixth to twelfth grades. He found that prior achievement accounted for about 16 to 25 percent of variance related to science achievement. In the 34 studies examined, he found the relationship between ability and achievement to be very stable and that the ability measures were better predictors of cognitive achievement than developmental measures.

The meta-analysis conducted by Fleming and Malone (1982) focused on the relationships between student characteristics and student performance in science. They examined the relationships of the variables of general ability, language ability, and mathematical ability with performance measures. Results obtained in the analysis were quite similar in that they correlated almost equally with cognitive level measures ranging from .47 to .53. These findings were comparable to the results obtained by Boulanger's (1980) synthesis of 34 studies where the mean correlation between student outcomes and general ability was .49.

More recently, Walberg (1986) synthesized the research on teaching and reported a mean correlation of the ability and learning in science of .48 based on 10 studies.

Attitudes

When examining the social and psychological influences on science learning, Kremer and Walberg (1980) found that all of the studies of student motivation and science achievement in their meta-analysis showed positive relationships between motivational variables and learning. The mean correlation for student motivation was .37. Although the number of studies was limited (n=5), the results concurred with previous studies of student motivation and general educational achievement conducted by Bloom (1976) and Uguroglu and Walberg (1979). Median correlations of .35 and .30 respectively were reported.

As one of the variables considered in the meta-analysis of Fleming and Malone (1982), attitude was found to have a mean correlation of .23 with science achievement. The results were based on seven studies. A higher correlation of .31 was reported by Kahl (1982) based on four studies of the relationship of science and attitude/motivation.

Sex

Sex differences in science achievement were investigated in several reviews and meta-analyses studies. From an international study involving 19 countries, Comber and Keeves (1973) found that boys achieved better than girls in science (one-fourth of a standard deviation) and that sex accounted for 2 percent of variance in science achievement.

Results from the National Assessment of Educational Progress in varying years consistently indicated that boys achieved slightly better than girls (Haertel et al., 1981; deBenedictis et al., 1982; Hueftle et al., 1983).

Fleming and Malone (1982) included sex as a variable in their meta-analysis on student characteristics and science performance and reported that a mean correlation of .04 was found in the nine studies considered in the analysis.

A meta-analysis review conducted by Maehr and Steinkamp (1983) reported that boys consistently achieved slightly higher than girls in elementary school science. Age difference was also examined in the analysis of Erickson and Erickson (1984). They demonstrated that the sex difference in science achievement was not significant at early ages, but that a difference was apparent as age increased in favor of male achievement.

Findings from major reviews of research and meta-analyses studies have revealed that significant antecedents to student achievement exist. Prior knowledge was found to account for 25 to 36 percent of variance in studies examining science achievement. Scholastic ability comparably explained for 16 to 25 percent of variance in science achievement. Mean correlations of .30 to .37 were found to exist between attitude and science achievement. Although differences in sex and achievement have been noted, vari-

ances and correlations have been quite low. These findings on student characteristics and science achievement suggest that variables such as prior learning and attitude serve as antecedents for students' success in learning.

CHAPTER III

RESEARCH DESIGN AND PROCEDURES

Procedures involved in the study are reviewed in this chapter, which is organized in five sections. They are: overall design; population; instrumentation; data collection procedures; and statistical analysis.

OVERALL DESIGN

This study consisted of two major phases. The first stage focused on instrument development and assessment, while the second examined the influence of field instruction strategies on students' understanding and retention of selected ecological concepts.

The Student Ecology Assessment (SEA) instrument was developed as one means of obtaining information about students' understanding of concepts related to ecology and feeding relationships (Appendix A). A background/attitude form which contained items on students' academic standing, science background, science interests, science extracurricular involvements, learning preference, and travel and outdoor experience was also developed and administered (Appendix B).

Student testing occurred prior to, during, and four weeks after the instructional program. An experiential field program was conducted in a marine setting and served as the learning strategy. Instruction on ecology comprised one part of the total field program and was monitored in terms of the time and emphasis that each of the targeted concepts received. Students and teachers indicated their perception of time and emphasis given to each major concept area on a separate report form (Appendix C). This information was also included in the analysis.

POPULATION

Populations under investigation in this study consisted of secondary schools which had marine science field programs. Assistance in identifying potential participants for the study was provided from two educational nature-oriented travel organizations, International Field Studies Inc. and International Expeditions Inc. These organizations specialize in coordinating the travel arrangements and contributing to the educational programs of field excursions. A listing of schools which had formal educational programs that would be completed within the study's time frame was obtained from these organizations and individual schools were contacted for possible participation in the study. Only schools with programs that had a struc-

tured field component which included a series of pretrip and posttrip sessions were considered. Three programs from two high school were selected for the study. These included: Bexley High School, Bexley, Ohio (two groups) and South Lake High School, Fairfax, Virginia. All programs occurred from 27 December 1986 to 3 January 1987. They were conducted at different geographic sites. Two programs occurred at sites on Andros Island, Bahamas, and one was directed on the Grand Cayman Islands.

INSTRUMENTATION

Data on students and on the instructional program were obtained from instruments developed for this study. Student inventories included the Student Ecology Assessment (SEA) instrument and a Student Background/Attitude form (Appendices A/B). Information on the instructional program was procured through teacher and student responses to the Instructional Emphasis form (Appendix C).

Student Concept Understanding

Procedures involved in the development of the SEA instrument included: 1) selection of concept areas (determined through a review of curricula programs, textbooks, and practicum materials and through a concept map of these findings - Appendix D); 2) construction of items (reflecting patterns of items that progressed from concrete to

abstract, simple to complex, familiar to unfamiliar, and factual based to higher order questions); and 3) field testing with four distinct groups of high school students from Akron and Columbus, Ohio (resulting in three revisions based on item analysis, correlational analyses, and student and teacher feedback).

The first draft of the Student Ecology Assessment (SEA) was reviewed by faculty members from The Ohio State University's Department of Educational Theory and Practice and the School of Natural Resources as well as science field studies program administrators and educators from Florida, Alabama, and Ohio. The ideas and suggestions expressed by these individuals were incorporated in the second version of the instrument. This instrument was then administered to two groups (n=16 and 14) of secondary biology students from a suburb of Akron, Ohio. Statistical analysis of student responses and feedback from the participating teachers formed the basis of the third revision of the instrument. In this draft, the number of items was collapsed reducing the number of items from 61 to 40. Some of the items were re-written to improve clarity.

After further modification, the revised instrument was then given to two groups of secondary science students (n=29 and 28) from an urban private school in Columbus, Ohio. Test results, informal comments from the participat-

ing groups, and suggestions from additional reviewers were used in another revision of the SEA instrument. The major change occurred in the format of the items with nearly all items being restructured into a multiple choice pattern. This version (the fourth) served as the testing instrument in the study. Summary statistics of pilot test results are provided in Table 1. The statistical program, ItemA Statpack (Ohio State University, 1982) was utilized for the analysis. Information from this analysis was used primarily to determine the instrument's reliability. Summary statistics are also presented in Tables 2 through 4 for each participating group . Although data are provided for pretest, posttests, and retention tests, only pretest data were considered in assessing the instrument's reliability since instruction was designed to lead students to mastery of the concepts and not to discriminate. This is evidenced in the data and is apparent in the reported measures of central tendency.

Table 1

STUDENT ECOLOGY ASSSESSMENT PILOT TESTS SUMMARY STATISTICS

	Group One (Form 2)	Group Two (Form 2)	Group Three (Form 3)	Group Four (Form 3)
Student #	16	14	29	28
Item #	61	61	40	40
Mean Score	38.88	34.43	22.14	21.11
Median	40	33	22	22
Mode	34	33	21	23
Maximum	48	45	31	35
Minimum	25	15	10	12
Range	23	30	21	23
Stand. Dev.	5.37	7.55	4.84	4.49
KR20	0.70	0.83	0.71	0.68
Mean Diff.	0.36	0.44	0.45	0.47
Mean Disc.	0.20	0.28	0.29	0.29

Table 2

STUDENT ECOLOGY ASSSESSMENT SUMMARY STATISTICS - GROUP ONE

(Form Four)	Pretest	Posttest	Retention
Student No.	29	29	29
Item No.	40	40	40
Mean Score	25.86	32.45	31.79
Median	25	33	33
Mode	27	33	33
Maximum	35	38	36
Minimum	16	19	23
Range	19	19	13
Stand. Dev.	4.30	3.99	3.01
KR20	0.62	*	*
Mean Diff.	0.35	*	*
Mean Disc.	0.25	*	*

* data are inappropriate because of mastery emphasis

Table 3

STUDENT ECOLOGY ASSESSMENT SUMMARY STATISTICS - GROUP TWO

(Form Four)	Pretest	Posttest	Retention
Student No.	21	21	21
Item No.	40	40	40
Mean Score	28.71	35.19	34.67
Median	28	35	35
Mode	28	39	37
Maximum	36	39	38
Minimum	9	30	30
Range	27	9	8
Stand. Dev.	5.76	2.70	2.10
KR20	0.83	*	*
Mean Diff.	0.28	*	*
Mean Disc.	0.30	*	*

* data are inappropriate because of mastery emphasis

Table 4

STUDENT ECOLOGY ASSESSMENT SUMMARY STATISTICS - GROUP THREE

(Form Four)	Pretest	Posttest	Retention
Student No.	29	29	29
Item No.	40	40	40
Mean Score	26.69	35.93	35.17
Median	27	36	36
Mode	25	35	36
Maximum	35	39	38
Minimum	11	29	31
Range	24	10	7
Stand. Dev.	5.36	1.91	1.93
KR20	0.80	*	*
Mean Diff.	0.33	*	*
Mean Disc.	0.35	*	*

* data are inappropriate because of mastery emphasis

Changes were significantly evidenced in the pre to post-test results. The field experience was used to clarify and/or extend the students' understanding of the ecological concepts. Tables 5 through 7 report the difficulty of the items in the SEA instrument and indicate the students' improvement and gains in responding correctly to the items of the test. Maximum difficulty is expressed as 1.000, while .000 indicates the lowest difficulty level with all students responding correctly.

Table 5

ITEM DIFFICULTY -- GROUP ONE (n=29)

ITEM	PRETEST	POSTTEST	RETENTION
1.	.000	.034	.000
2.	.448	.103	.069
3.	.690	.241	.000
4.	.724	.586	.345
5.	.276	.069	.000
6.	.172	.069	.034
7.	.103	.069	.034
8.	.069	.103	.103
9.	.690	.414	.552
10.	.862	.621	.207
11.	.552	.103	.241
12.	.138	.034	.000
13.	.310	.069	.069
14.	.310	.000	.034
15.	.241	.103	.034
16.	.241	.069	.241
17.	.310	.069	.276
18.	.241	.138	.414
19.	.345	.448	.310
20.	.586	.448	.172
21.	.379	.172	.069
22.	.069	.000	.000
23.	.034	.000	.000
24.	.034	.000	.034
25.	.483	.517	.586
26.	.207	.034	.241
27.	.345	.345	.310
28.	.379	.069	.241
29.	.621	.276	.483
30.	.483	.103	.172
31.	.552	.345	.586
32.	.241	.172	.241
33.	.552	.241	.138
34.	.172	.103	.069
35.	.172	.034	.034
36.	.069	.034	.000
37.	.517	.172	.310
38.	.483	.241	.310
39.	.414	.310	.448
40.	.621	.586	.793

Table 6

ITEM DIFFICULTY -- GROUP TWO (n=21)

ITEM	PRETEST	POSTTEST	RETENTION
1.	.000	.000	.000
2.	.238	.095	.048
3.	.619	.048	.048
4.	.905	.429	.429
5.	.048	.000	.000
6.	.238	.000	.000
7.	.095	.000	.000
8.	.286	.143	.190
9.	.714	.381	.143
10.	.619	.238	.524
11.	.286	.095	.000
12.	.000	.048	.000
13.	.190	.048	.048
14.	.143	.048	.048
15.	.143	.048	.048
16.	.190	.048	.000
17.	.190	.000	.048
18.	.190	.143	.095
19.	.476	.190	.048
20.	.429	.190	.190
21.	.286	.048	.095
22.	.048	.000	.000
23.	.048	.000	.000
24.	.048	.000	.000
25.	.476	.238	.429
26.	.095	.048	.000
27.	.524	.381	.190
28.	.238	.143	.190
29.	.286	.333	.381
30.	.381	.095	.048
31.	.381	.286	.381
32.	.095	.048	.095
33.	.190	.048	.048
34.	.190	.048	.095
35.	.190	.048	.095
36.	.143	.000	.048
37.	.286	.048	.143
38.	.286	.048	.095
39.	.429	.190	.286
40.	.667	.571	.810

Table 7

ITEM DIFFICULTY -- GROUP THREE (n=29)

ITEM	PRETEST	POSTTEST	RETENTION
1.	.000	.000	.000
2.	.345	.034	.034
3.	.724	.103	.034
4.	.793	.310	.517
5.	.172	.000	.034
6.	.172	.000	.034
7.	.000	.000	.034
8.	.414	.000	.103
9.	.759	.517	.414
10.	.862	.172	.345
11.	.448	.000	.103
12.	.207	.000	.034
13.	.138	.000	.034
14.	.138	.000	.034
15.	.552	.345	.207
16.	.276	.000	.034
17.	.241	.000	.034
18.	.276	.000	.069
19.	.310	.172	.241
20.	.793	.069	.276
21.	.207	.103	.069
22.	.000	.000	.034
23.	.103	.000	.034
24.	.034	.000	.034
25.	.517	.310	.517
26.	.034	.000	.034
27.	.379	.310	.207
28.	.138	.000	.103
29.	.414	.069	.103
30.	.276	.034	.069
31.	.759	.138	.345
32.	.310	.207	.310
33.	.379	.138	.069
34.	.207	.000	.034
35.	.207	.000	.034
36.	.034	.000	.034
37.	.241	.069	.138
38.	.241	.069	.138
39.	.379	.172	.310
40.	.838	.724	.793

Modifications to the SEA instrument included changes in format, wording, and number of items in the instrument. However, the concept strands that were initially targeted for study remained the same. The items were clustered into eight categories. These divisions focused on: 1) plant and animal characteristics (items 1-4); 2) plant and animal identification (items 5-8); 3) plant and animal habitats (items 9-11); 4) food chains (items 12-19); 5) food webs (items 20-30); 6) energy transfer (items 31-32); 7) energy pyramids (items 33-38); and 8) nutrient cycles (items 39-40). Tables 8 through 10 indicate the difficulty levels of items within each cluster area. The items are recorded according to their intended level of difficulty which was based on the nature of the item; that is, items that were familiar or concrete were projected to be less difficult than the items that were unfamiliar and abstract, which would reflect a higher level of difficulty. A hierarchial pattern was incorporated into each of the concept clusters. Difficulty is recorded progressively from left to right in the tables. Most items show a pattern of decreasing difficulty from the pretest to the posttest results as well as in the retention readings, thus indicating that the concepts addressed in these items were learned and retained.

Table 8

ITEM HIERARCHIES AND DIFFICULTIES - GROUP ONE (n=29)

(Arranged from Familiar/Concrete to Unfamiliar/Abstract)

CLUSTER ONE - PLANT AND ANIMAL CHARACTERISTICS

	#1	#2	#3	#4
Pretest	.00	.45	.69	.72
Posttest	.03	.10	.24	.57
Retention	.00	.06	.00	.34

CLUSTER TWO - PLANT AND ANIMAL IDENTIFICATION

	#8	#6	#7	#5
Pretest	.07	.17	.10	.28
Posttest	.10	.06	.07	.07
Retention	.10	.03	.03	.00

CLUSTER THREE - PLANT AND ANIMAL HABITATS

	#11	#10	#9
Pretest	.55	.86	.69
Posttest	.10	.62	.41
Retention	.24	.20	.55

CLUSTER FOUR - FOOD CHAINS

	#12	#13	#14	#16	#15	#17	#18	#19
Pretest	.14	.31	.31	.24	.24	.31	.24	.36
Posttest	.03	.07	.00	.07	.10	.07	.14	.45
Retention	.00	.07	.03	.24	.03	.28	.41	.31

CLUSTER FIVE - FOOD WEBS

	#22	#23	#24	#26	#21	#28	#30	#29	#27	#25	#20
Pretest	.07	.03	.03	.21	.38	.38	.48	.62	.35	.48	.57
Posttest	.00	.00	.00	.03	.17	.07	.10	.28	.35	.52	.45
Retention	.00	.00	.03	.24	.07	.24	.17	.48	.31	.57	.31

CLUSTER SIX - ENERGY TRANSFER (FOOD)

	#32	#31
Pretest	.24	.55
Posttest	.17	.35
Retention	.24	.57

CLUSTER SEVEN - ENERGY PYRAMIDS

	#36	#34	#35	#37	#38	#33
Pretest	.07	.17	.17	.52	.48	.55
Posttest	.03	.10	.03	.17	.24	.24
Retention	.00	.07	.03	.31	.31	.14

CLUSTER EIGHT - NUTRIENT CYCLES (CARBON)

	#39	#40
Pretest	.41	.62
Posttest	.31	.57
Retention	.45	.79

Table 9

ITEM HIERARCHIES AND DIFFICULTIES - GROUP TWO (n=21)

(Arranged from Familiar/Concrete to Unfamiliar/Abstract)

CLUSTER ONE - PLANT AND ANIMAL CHARACTERISTICS

	#1	#2	#3	#4
Pretest	.00	.24	.62	.91
Posttest	.00	.09	.05	.43
Retention	.00	.05	.05	.43

CLUSTER TWO - PLANT AND ANIMAL IDENTIFICATION

	#8	#6	#7	#5
Pretest	.27	.24	.09	.05
Posttest	.14	.00	.00	.00
Retention	.19	.00	.00	.00

CLUSTER THREE - PLANT AND ANIMAL HABITATS

	#11	#10	#9
Pretest	.28	.62	.71
Posttest	.10	.24	.38
Retention	.00	.52	.14

CLUSTER FOUR - FOOD CHAINS

	#12	#13	#14	#16	#15	#17	#18	#19
Pretest	.00	.19	.14	.19	.14	.19	.19	.48
Posttest	.05	.05	.05	.05	.05	.00	.14	.19
Retention	.00	.05	.05	.00	.05	.05	.10	.05

CLUSTER FIVE - FOOD WEBS

	#22	#23	#24	#26	#21	#28	#30	#29	#27	#25	#20
Pretest	.05	.05	.05	.10	.27	.24	.38	.27	.52	.48	.43
Posttest	.00	.00	.00	.05	.05	.14	.10	.33	.38	.24	.19
Retention	.00	.00	.00	.00	.10	.19	.05	.38	.19	.43	.19

CLUSTER SIX - ENERGY TRANSFER (FOOD)

	#32	#31
Pretest	.10	.38
Posttest	.05	.27
Retention	.10	.38

CLUSTER SEVEN - ENERGY PYRAMIDS

	#36	#34	#35	#37	#38	#33
Pretest	.14	.19	.19	.27	.27	.19
Posttest	.00	.05	.05	.05	.05	.05
Retention	.05	.10	.10	.14	.14	.05

CLUSTER EIGHT - NUTRIENT CYCLES (CARBON)

	#39	#40
Pretest	.43	.68
Posttest	.19	.57
Retention	.27	.81

Table 10

ITEM HIERARCHIES AND DIFFICULTIES - GROUP THREE (n=29)

(Arranged from Familiar/Concrete to Unfamiliar/Abstract)

CLUSTER ONE - PLANT AND ANIMAL CHARACTERISTICS

	#1	#2	#3	#4
Pretest	.00	.35	.72	.79
Posttest	.00	.03	.10	.31
Retention	.00	.03	.03	.52

CLUSTER TWO - PLANT AND ANIMAL IDENTIFICATION

	#8	#6	#7	#5
Pretest	.41	.17	.00	.17
Posttest	.00	.00	.00	.00
Retention	.10	.03	.03	.03

CLUSTER THREE - PLANT AND ANIMAL HABITATS

	#11	#10	#9
Pretest	.45	.86	.76
Posttest	.00	.17	.52
Retention	.10	.35	.41

CLUSTER FOUR - FOOD CHAINS

	#12	#13	#14	#16	#15	#17	#18	#19
Pretest	.21	.14	.14	.28	.55	.24	.28	.31
Posttest	.00	.00	.00	.00	.35	.00	.00	.17
Retention	.03	.03	.03	.03	.21	.03	.07	.24

CLUSTER FIVE - FOOD WEBS

	#22	#23	#24	#26	#21	#28	#30	#29	#27	#25	#20
Pretest	.00	.10	.03	.03	.21	.14	.28	.41	.38	.52	.79
Posttest	.00	.00	.00	.00	.10	.00	.03	.07	.31	.31	.07
Retention	.03	.03	.03	.03	.07	.10	.07	.10	.21	.52	.28

CLUSTER SIX - ENERGY TRANSFER (FOOD)

	#32	#31
Pretest	.31	.76
Posttest	.21	.14
Retention	.31	.34

CLUSTER SEVEN - ENERGY PYRAMIDS

	#36	#34	#35	#37	#38	#33
Pretest	.03	.21	.21	.24	.24	.38
Posttest	.00	.00	.00	.07	.07	.14
Retention	.03	.03	.03	.14	.14	.07

CLUSTER EIGHT - NUTRIENT CYCLES (CARBON)

	#39	#40
Pretest	.38	.84
Posttest	.17	.72
Retention	.31	.79

Student Background and Attitudes

The student background and attitude form was designed to obtain information on students': 1) science academic standing; 2) sex; 3) grade level; 4) science course background; 5) science interests; 6) science extracurricular involvements; 7) perception of learnings; 8) learning style preference; and 9) travel and outdoor experience. A total of 50 possible responses were coded for the variables examined. Students were to provide only one response for 27 of the items, whereas more than one choice was possible for 21 items. Subtotals were also tallied for four categories of items (number of science courses taken, total countries visited, expressed interest in science-related events, and actual participation in science-related events).

Instructional Emphasis Perception

Perceptions of the emphasis given to each major concept area was reported by both teachers and students. Participants indicated the emphasis given to each topic at pretrip sessions, during the trip, and at the posttrip sessions.

DATA COLLECTION PROCEDURES

Data collection procedures are discussed in three general categories: student concept understandings; student background and attitude information; and instructional emphasis perceptions.

Student Concept Understandings

The pretest for the Student Ecology Assessment (SEA) Form 4 was administered to the students during one of each group's pretrip sessions. The SEA was re-administered directly in the field setting on the last evening of the seven-day excursion. The third testing occurred four weeks after the trip at each group's final posttrip meeting.

Student Background and Attitude Form

The students responded to the background and attitude inventory during one of the pretrip sessions. It was administered independently of the SEA instrument. All forms were coded to insure anonymity.

Instructional Emphasis Perception

Teachers indicated the coverage delivered for each targeted concept area and also recorded the nature of the coverage for each topic (i.e. activity, film, report, etc.). This occurred for the pretrip, trip, and posttrip sessions. Information was also requested on the time and emphasis devoted to administrative, procedural, and instructional tasks. The teachers were asked to specify the targeted concept areas that received most attention and also to indicate other science- related topics that were a part of the instructional program during the sessions. Students reported their perceptions of the emphasis given to each targeted concept area on a similar form.

STATISTICAL ANALYSIS

Statistical analysis procedures were conducted at the computing facilities of The Ohio State University and entailed use of programs from two statistical packages. An item analysis program, ItemA Statpack (1982), which originated at The Ohio State University, was employed in the development of the Student Ecology Assessment (SEA) instrument and was also used in the analysis of pretest, posttest, and retention responses. Data obtained from the SEA, the student background/attitude forms, and the instructional emphasis forms were subjected to selected programs contained within the Statistical Package for the Social Sciences (SPSSx). These included: frequency distributions; correlational analyses; and multiple regression analyses. Additional computations were also performed and included: adjusted gain scores; t test calculations; and percentages of possible gain.

Student responses on the SEA instrument and the background/attitude form were coded separately for statistical analysis. Initially, frequencies were obtained for the background/attitude instrument and then were entered for correlational analysis and regression analysis with the students' responses from the SEA instrument. Frequencies were also analyzed for student's responses to the SEA instrument and correlations were examined both within each

group and also between each of the tested groups. Comparisons of pretest to posttest results through t test analysis showed significant gains for each group ($p < .001$).

Overall, students evidenced significant gains in scores on the SEA instrument from pre to posttest responses. Results on the retention test also indicated that the concepts addressed in the instrument were retained by the students.

Student subscores for each of the eight major concept strands from the post and retention tests were then standardized into adjusted gain scores for further analysis. The adjusted gain scores were also entered into regression analyses. Teacher and student ratings of the instructional emphasis given to each of the eight major concept areas were also included in correlational and regression analyses.

Regressions conducted on each group included: 1) each pretest subscore and total score against background variables; 2) each posttest subscore total score against pretest subscores and background variables; 3) each posttest subscore and total score against background variables; 4) each post adjusted subscore and total score against pretest subscores and background variables; 5) each post adjusted subscore and total score against pretest subscores, background variables, and emphasis ratings; and 6) retention

adjusted gain scores against pretest subscores, background variables, post adjusted gain scores, and emphasis ratings. Results of the statistical analysis are presented in Chapter 4.

CHAPTER IV

RESULTS

There are five sections in this chapter. The first section presents frequencies of the variables addressed in this study for the purpose of showing the samples' characteristics. The second section reviews correlation findings. The third presents results of the multiple regression analyses. The fourth section reports percentages of gain and emphasis ratings. The fifth section includes a review related to the tests of the stated hypotheses. References are also made to the tables in the appendices.

DESCRIPTIVE STATISTICS

The student background and attitude form was designed to obtain information on selected characteristics of the participating students. Means and/or percentages related to items in the background/attitude form are provided in Tables 11 through 17.

Student Characteristics

Comparisons of the distribution of students' grade levels, sex, and mean prior science grade scores indicate the homogeneity of the sex ratio and science achievement means of the three groups. However, differences existed in the grade levels of the participating groups, with group three having all students from the 12th grade. Characteristics of the participating groups are found in the summaries of Tables 11 through 13.

Table 11

GRADE LEVEL OF STUDENTS IN THE PARTICIPATING GROUPS

GROUP	10th		11th		12th		TOTAL	
	n	%	n	%	n	%	n	%
1.	7	24%	10	35%	12	41%	29	100%
2.	8	38%	7	33%	6	29%	21	100%
3.	0	00%	0	00%	29	100%	29	100%

Table 12

DISTRIBUTION OF THE SEX OF THE PARTICIPATING GROUPS

GROUP	FEMALES		MALES	
	NUMBER	PERCENTAGE	NUMBER	PERCENTAGE
1.	18	62%	11	38%
2.	10	48%	11	52%
3.	13	45%	16	55%

Table 13

SCIENCE ACHIEVEMENT MEANS AND STANDARD DEVIATIONS OF THE PARTICIPATING GROUPS

GROUP	n	CURRENT COURSE MEAN GRADE	STAND DEV.	CUMULATIVE MEAN GRADE	STAND DEV.
1.	29	3.03	.958	3.04	.706
2.	21	3.42	.692	3.00	.973
3.	29	2.96	.566	2.96	.576

(A = 4.0; B = 3.0; C = 2.0; D = 1.0)

Student Attitudes

Students' attitudes toward science and science learning as expressed in selected items on the student background/attitude form are reported by percentages in Tables 14 through 16.

Table 14 indicates that nearly all students of the participating groups were highly positive in their perceptions of the amount of learning that was achieved in their science classes and were affirmative in responding that they generally enjoyed their science classes. Their desire to take additional science classes reflected a lower degree of agreement but was still positive.

Table 14

PERCENTAGE OF STUDENTS HOLDING POSITIVE ATTITUDES TOWARD SCIENCE CLASSES FOR THREE ITEMS

GROUP	n	ITEM 1	ITEM 2	ITEM 3
1.	29	90%	83%	97%
2.	21	100%	76%	100%
3.	29	100%	65%	100%

1. = Positive perception of the amount learned in science
2. = Desire to take more science classes
3. = Enjoyment of science classess

When the participating students were asked to indicate the modes of learning that they preferred in their science classes, the learning strategies that necessitate direct involvement and active participation were rated more highly than those that implied a passive means of learning. Therefore lectures and reading received the lowest ratings, whereas outdoor activities, group work, and laboratory exercises were selected by the highest percentage of students. Similarities again are common in these self selected groups. Table 15 reports these percentages.

Table 16 reports student responses to items which focused on science-related activities. Students were asked to specify both the science-related acitivities that they like to do as well as those that they had already done. Generally, it is seen that the participating groups actually participated in more activities than they stated that

Table 15

LEARNING STYLE PREFERENCE OF THE PARTICIPATING GROUPS

STYLE	GROUP ONE n=29		GROUP TWO n=21		GROUP THREE n=29	
	n	%	n	%	n	%
1.	7	24%	3	14%	6	21%
2.	23	79%	19	90%	23	79%
3.	22	76%	18	86%	26	90%
4.	27	93%	18	86%	28	97%
5.	4	14%	5	24%	5	17%

1. = Lectures
2. = Laboratory Exercises
3. = Group Work
4. = Outdoor Activities
5. = Reading

they had a preference for doing. This is readily apparent with the high percentage of students who had completed science fair projects in comparison with the low ratings that they gave for wanting to do them. Overall, the participating groups indicated that they both hiked and like to hike and have watched and prefer to watch science-related television programs.

Table 16

PERCENTAGES OF PREFERENCE AND INVOLVEMENT IN SCIENCE ACTIVITIES OF THE PARTICIPATING GROUPS

ACTIVITY	GROUP ONE n=29		GROUP TWO n=21		GROUP THREE n=29	
	n	%	n	%	n	%
1.	1	3%	4	19%	2	7%
2.	16	55%	19	90%	20	69%
3.	2	7%	2	10%	3	10%
4.	5	17%	8	38%	10	34%
5.	7	24%	11	52%	24	83%
6.	13	45%	6	29%	7	24%
7.	23	79%	19	90%	26	90%
8.	26	90%	19	90%	27	93%
9.	1	3%	3	14%	5	17%
10.	20	69%	14	66%	24	83%
11.	21	72%	18	86%	29	100%
12.	10	34%	8	38%	13	45%

1. = Like to do science fair projects
2. = Like to hike in the outdoors
3. = Like to belong to science clubs
4. = Like to read science magazines
5. = Like to watch science television programs
6. = Like to participate in enviromental projects
7. = Participated in science fairs
8. = Hiked in the outdoors
9. = Have been a member of a science club
10. = Read science magazines
11. = Watched science television programs
12. = Been involved in environmental projects

Travel and Outdoor Experience

In order to assess the participating groups' exposure to outdoor experiences and to travel, several items on the student background/attitude form were directed to obtaining information on these aspects. Generally, the participating students' attitude toward travel was highly favorable (90%

liked to travel) and the students were very well traveled. Table 17 summarizes and reports the findings in percentages concerning selected information on the participating students background for travel.

Table 17

TRAVEL AND OUTDOOR EXPERIENCE INDICATED BY THE PARTICIPATING GROUPS

EXPERIENCE	GROUP ONE n=29		GROUP TWO n=21		GROUP THREE n=29	
	n	%	n	%	n	%
1.	28	97%	20	95%	29	100%
2.	28	97%	20	95%	29	100%
3.	13	45%	15	71%	22	76%
4.	27	86%	20	95%	28	97%
5.	18	62%	12	57%	19	66%
6.	9	31%	5	24%	7	24%
7.	10	34%	2	10%	5	17%
8.	0	0%	0	0%	2	7%
9.	7	24%	4	20%	16	55%
10.	0	0%	0	0%	1	3%
11.	2	7%	1	5%	5	17%
12.	0	0%	0	0%	0	0%
13.	4	14%	0	0%	6	21%

1. = Took trips that were more than 3 days long (in a year)
2. = Traveled a distance greater than 50 miles (in a year)
3. = Camped overnight (at least once a year)
4. = Would like to travel to new and different places
5. = Traveled to Canada
6. = Traveled to Mexico
7. = Traveled to the Caribbean
8. = Traveled to Asia
9. = Traveled to Europe
10 = Traveled to Africa
11. = Traveled to South America
12. = Traveled to Australia
13. = Traveled to Hawaii or Alaska

CORRELATIONS

Since the significant correlations between variables appear in the regression results and are reported there, separate tables do not appear in the text or appendix.

REGRESSIONS

The variables were entered and considered in the analysis which consisted initially of generation of Pearson product- moment correlation coefficient matrices for each group's scores. All measured variables were included in each matrix. Those that had a pattern of significance ($p < .05$) were identified. These variables were entered into stepwise regression analyses on the subscores and total scores of the Student Ecology Assessment (SEA). Regression analyses conducted on each of the three groups separately included: 1) each pretest subscore and total score against background variables; 2) each posttest subscore and total score against background variables; 3) each posttest subscore and total score against pretest scores and background variables; 4) each post adjusted subscore and total score against pretest subscores and background variables; 5) each post adjusted subscore and total score against pretest subscores, background variables, and emphasis ratings; and 6) retention adjusted gain scores against pretest subscores, background variables, post adjusted gain scores, and emphasis ratings.

Because of the differences among the three participating groups, the regression analyses were performed separately for each group and are reported in this fashion. Since distinct concept strands were examined in the Student Ecology Assessment (SEA), they also were analyzed separately. Results are specified for each subscore which measured the concept strands. The total score is also reported. The sequence of reporting the regression results is as follows: 1) group one; 2) group two; and 3) group three. Results within these groups are presented in the following manner: 1) pretest by background variables; 2) posttest by background and pretest scores; 3) adjusted gain by background, pretest, and posttest scores; and 4) adjusted retention gain by background, pretest, posttest, and adjusted posttest gain scores.

The major predictors that emerged in each regression at ($p < .05$) are specified in the tables. In some cases, the variance accounted for by these variables may block the emergence of the other potential predictors. Therefore the tables represent only the most significant of the possible predictors. Predictors that emerged from free regressions ($p > .05$) are provided in Appendix G. In cases where no predictor emerged, tables are not included for that subscore. Complete lists of variable names are provided in Appendices E and F.

Group One

Pretest Scores against Background Variables

Subscore 1 - Plant and Animal Characteristics:

Since no predictor emerged, a table is not included.

Subscore 2 - Plant and Animal Identification:

In this analysis two predictors were identified. The students' indication of watching science television programs accounted for 15 percent of the variance and travel experience to Canada, accounted for an additional 14 percent, explaining a total of 29 percent of the variance. See Table 18.

Table 18

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 2 FOR GROUP ONE (n=29)

MULTIPLE R	.53501
R SQUARE	.28623
ADJUSTED R SQUARE	.23133
STANDARD ERROR	.71893

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	5.38905	2.59453
RESIDUAL	26	13.43854	.51687
F = 5.21319		SIGNIF F = .0125	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
WV	.70008	.29870	.38833	2.344
C	.61464	.27154	.37013	2.232

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	WV	.3863	.1492	.1177	4.736	.038	.1492
2	C	.5350	.2862	.2313	5.213	.012	.1370

WV Watched science television programs (actually done)
C Travel out of the United States (Canada)

Subscore 3 - Plant and Animal Habitats:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 100 in Appendix G.

Subscore 4 - Food Chains:

The predictor variable identified in this analysis was the indication of the students' positive perception that they did learn in their science classes. The variance accounted by this variable was 19 percent. Refer to Table 19.

Table 19

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 4 FOR GROUP ONE (n=29)

MULTIPLE R	.43418
R SQUARE	.18851
ADJUSTED R SQUARE	.14580
STANDARD ERROR	1.62882

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	11.71006	11.71006
RESIDUAL	19	50.40816	2.65306
F = 4.41379		SIGNIF F = .0492	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
Q	1.14285	.54398	.43418	2.101

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	Q	.4342	.1885	.1458	4.414	.049	.1885

Q Perception of Learning in Science

Subscore 5 - Food Webs:

Two variables were identified in this analysis: the students' indication of experience in hiking outdoors, which accounted for 21 percent of the variance, and the students' expression of liking to view science-related television programs, which accounted for an additional 19 percent, explained a total of 40 percent of the variance. Table 20 reports the results.

Table 20

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 5 FOR GROUP ONE (n=29)

MULTIPLE R	.63431
R SQUARE	.40223
ADJUSTED R SQUARE	.35624
STANDARD ERROR	1.52567

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	40.72196	20.36098
RESIDUAL	26	60.51942	2.32767
F = 8.74737		SIGNIF F = .0012	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
HO	3.00485	.93276	.48977	3.221
TV	1.92233	.66383	.44026	2.896

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	HO	.4576	.2094	.1801	7.153	.013	.2094
2	TV	.6342	.4022	.3562	8.747	.001	.1928

HO Hiked outdoors
TV Like to watch science television programs

Subscore 6 - Energy Transfer (Food):

Two variables were identified in this analysis: the students' desire to take more science classes, which accounted for 18 percent of the variance, and the desire of students to read science books and magazines, which accounted for an additional 14 percent, explained a total of 32 percent of the variance. Refer to Table 21.

Table 21

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 6 FOR GROUP ONE (n=29)

MULTIPLE R	.56815
R SQUARE	.32280
ADJUSTED R SQUARE	.27071
STANDARD ERROR	.67147

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	5.58775	2.79387
RESIDUAL	26	11.72660	.45087
F = 6.19664		SIGNIF F = .0063	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
MM	.38768	.13528	.46558	2.866
RM	.78484	.33230	.38372	2.362

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	MM	.4213	.1775	.1470	5.827	.023	.1775
2	RM	.5682	.3228	.2707	6.197	.006	.1453

MM Would like to take additional science classes
RM Read science magazines or books

Subscore 7 - Energy Pyramids:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 101 in Appendix G.

Subscore 8 - Nutrient Cycles:

Two variables were identified in this analysis: the indication that the students traveled a distance of 50 miles or more each year, which accounted for a variance of 15 percent, and the cumulative score of science-related activities performed, which accounted for an additional 13 percent, explained a total of 28 percent of the variance. The results are presented in Table 22.

Table 22

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 8 FOR GROUP ONE (n=29)

MULTIPLE R	.53310
R SQUARE	.28419
ADJUSTED R SQUARE	.22913
STANDARD ERROR	.52470

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	2.84194	1.42097
RESIDUAL	26	7.15806	.27531
F = 5.16134		SIGNIF F = .0130	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TM	.31891	.12873	.41200	2.477
GTG	.20789	.09409	.36745	2.209

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TM	.3870	.1498	.1183	4.757	.038	.1498
2	GTG	.5331	.2842	.2291	5.161	.013	.1344

TM Traveled a distance of more than 50 miles (in a year)
GTG Total of science-related activities performed

Total Score of the Pretest:

The predictor variable identified in this analysis was the students' preference for reading as a mode of learning science. The variance accounted by this variable was 23 percent. Table 23 reports the findings.

Table 23

REGRESSION OF BACKGROUND VARIABLES ON PRETEST TOTAL SCORE FOR GROUP ONE (n=29)

MULTIPLE R	.47829
R SQUARE	.22876
ADJUSTED R SQUARE	.18591
STANDARD ERROR	3.94562

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	83.11704	83.11704
RESIDUAL	18	280.22286	15.56794

F = 5.33899 SIGNIF F = .0329

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
Y	5.96000	2.57938	.47828	2.311

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	Y	.4783	.2288	.1859	5.339	.033	.2288

Y Reading as a preferred way to learn science

Posttest Scores against Background and Pretest Scores

Subscore 1 - Plant and Animal Characteristics:

The predictor variable identified in this analysis was the indication that students frequently watch science television programs. The variance accounted by this variable was 30 percent. Refer to Table 24.

Table 24

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 1 FOR GROUP ONE (n=29)

MULTIPLE R	.54410
R SQUARE	.29605
ADJUSTED R SQUARE	.25025
STANDARD ERROR	.78234

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	4.12787	4.12787
RESIDUAL	16	9.18548	.61347
F = 6.72876		SIGNIF F = .0196	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
WV	1.08333	.41763	.54410	2.594

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	WV	.5441	.2960	.2520	6.729	.020	.2960

WV Watched science television programs

Subscore 2 - Plant and Animal Identification:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 102 in Appendix G.

Subscore 3 - Plant and Animal Habitats:

In this analysis two predictors were identified. The students' current science grade accounted for 33 percent of the variance and travel experience to Europe accounted for an additional 17 percent, explaining a total of 50 percent of the variance. Table 25 reports the results of the analysis.

Table 25

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 3 FOR GROUP ONE (n=29)

MULTIPLE R	.70829
R SQUARE	.50168
ADJUSTED R SQUARE	.43524
STANDARD ERROR	.41865

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	2.64680	1.32340
RESIDUAL	15	2.62906	.17527
F = 7.55060		SIGNIF F = .0054	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
CG	.33944	.05973	.58395	3.203
E	.52790	.23320	.41268	2.264

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	CG	.5757	.3314	.2897	7.932	.012	.3314
2	E	.7083	.5017	.4352	7.551	.005	.1702

CG Current science grade
E Travel out of the United States (Europe)

Subscore 4 - Food Chains:

The predictor variable identified in this analysis was the students' desire to travel to new and different place. The variance accounted for by this variable was 25 percent. The results are presented in Table 26.

Table 26

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 4 FOR GROUP ONE (n=29)

MULTIPLE R	.50000
R SQUARE	.25000
ADJUSTED R SQUARE	.20313
STANDARD ERROR	1.26088

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	8.47906	8.47906
RESIDUAL	16	25.43719	1.58982
F = 5.33333		SIGNIF F = .0346	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
DP	2.64626	1.14586	.50000	2.309

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	DP	.5000	.2500	.2031	5.333	.035	.2500

DP Desire to travel to new and different places

Subscore 5 - Food Webs:

The predictor variable identified in this analysis was the students' travel experience to Mexico (students who did not have the experience). The variance accounted for by this variable was 27 percent. Refer to Table 27.

Table 27

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 5 FOR GROUP ONE (n=29)

MULTIPLE R	.52154
R SQUARE	.27200
ADJUSTED R SQUARE	.22650
STANDARD ERROR	1.31887

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	10.39831	10.39831
RESIDUAL	16	27.83075	1.73942
F = 5.97803		SIGNIF F = .0264	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
M	-1.66111	.67939	-.52153	-2.445

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	M	.5215	.2720	.2265	5.978	.026	.2720

M Travel out of the United States (Mexico)

Subscore 6 - Energy Transfer (Food):

In this analysis two variables were identified. The students' overall grade average accounted for 30 percent of the variance and the students' desire to take more science courses accounted for an additional 18 percent, explaining a total of 48 percent of the variance. The results of this analysis are presented in Table 28.

Table 28

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 6 FOR GROUP ONE (n=29)

MULTIPLE R	.69458
R SQUARE	.48244
ADJUSTED R SQUARE	.41343
STANDARD ERROR	.52668

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	3.87850	1.93925
RESIDUAL	15	4.16091	.27739
F = 6.99095		SIGNIF F = .0072	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
V	.06795	.02121	.59859	3.203
MM	.30914	.13611	.42448	2.271

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	V	.5518	.3044	.2610	7.003	.018	.3044
2	MM	.6946	.4824	.4134	6.991	.007	.1780

V Cumulative science grade mean
MM Desire to take additional science classes

Subscore 7 - Energy Pyramids:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 103 in Appendix G.

Subscore 8 - Nutrient Cycles:

The predictor variable identified in this analysis was the preference for lodge facilities while in the outdoors (students who did not prefer lodges). The variance accounted for by this variable was 24 percent. Refer to Table 29 for the results.

Table 29

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 8 FOR GROUP ONE (n=29)

MULTIPLE R	.48795
R SQUARE	.23810
ADJUSTED R SQUARE	.19048
STANDARD ERROR	.60570

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1.83441	1.83441
RESIDUAL	16	5.87002	.36688
F = 5.00009		SIGNIF F = .0399	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
LX	-.64908	.29025	-.487953	-2.236

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	LX	.4880	.2381	.1905	5.000	.040	.2381

LX Prefer lodge facilities while exploring the outdoors

Total Posttest Score:

The predictor variable identified in this analysis was the students' positive perception of their learning in their science classes. The variance accounted by this variable was 36 percent. Refer to Table 30 for results.

Table 30

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST TOTAL SCORE FOR GROUP ONE (n=29)

MULTIPLE R	.59826
R SQUARE	.35792
ADJUSTED R SQUARE	.31779
STANDARD ERROR	3.35206

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	100.21653	100.21653
RESIDUAL	16	179.78100	11.23631

F = 8.91899 SIGNIF F = .0087

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
Q	3.626374	1.214269	.59826	2.986

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	Q	.5983	.3579	.3178	8.919	.009	.3579

Q Positive perception of learning in science

Adjusted Gain Scores against Background and Pretest Scores

Subscore 1 - Plant and Animal Characteristics:

In this analysis two variables were identified. The pretest subscore 1 (students who scored low on the pretest made the most gain) accounted for 49 percent of the variance and the students' indication of watching science tele-

vision programs accounted for an additional 14 percent, explaining a total of 63 percent of the variance. Table 31 contains the results of this analysis.

Table 31

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 1 FOR GROUP ONE (n=29)

MULTIPLE R	.79477
R SQUARE	.63166
ADJUSTED R SQUARE	.58254
STANDARD ERROR	.79779

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	16.37171	8.18586
RESIDUAL	15	9.54701	.63647
F = 12.8614		SIGNIF F = .0006	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T1	-.94304	.21497	-.69116	-4.410
WV	1.03726	.42543	.38210	2.438

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T1	.6969	.4835	.4535	15.109	.001	.4857
2	WV	.6317	.6317	.5825	12.861	.001	.1460

T1 Pretest Subscore 1
WV Watched science television programs

Subscore 2 - Plant and Animal Identification:

The predictor variable identified in this analysis was the pretest subscore 2 (students who scored low on the pretest made the most gains). The variance accounted for 65 percent of the variance. Refer to Table 32 for the results.

Table 32

REGRESSION OF BACKGROUND AND PRETEST RESULTS ON ADJUSTED GAIN SUBSCORE 2 FOR GROUP ONE (n=29)

MULTIPLE R	.80846
R SQUARE	.65361
ADJUSTED R SQUARE	.63196
STANDARD ERROR	.54027

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	8.81243	8.81243
RESIDUAL	16	4.67033	.29190
F = 30.19034		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T2	-.92307	.16799	-.80846	-5.495

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T2	.8085	.6536	.6320	30.190	.000	.6536

T2 Pretest subscore 2

Subscore 3 - Plant and Animal Habitats:

Three variables were identified in this analysis. The pretest subscore 3 (students who scored low on the pretest made the most gains) accounted for 57 percent of the variance. Other variables included: the students' current science grade and the students' ninth grade science achievement mean (students who had a low achievement mean made the most gains). These variables contributed 12 percent and 9 percent, respectively, to the variance explaining a total of 78 percent of the variance. Refer to Table 33.

Table 33

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 3 FOR GROUP ONE (n=29)

MULTIPLE R	.88348
R SQUARE	.78053
ADJUSTED R SQUARE	.73350
STANDARD ERROR	.54289

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	3	14.67433	4.89144
RESIDUAL	14	4.12616	.29473
F = 16.59658		SIGNIF F = .0001	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T3	-.84697	.16517	-.65801	-5.128
CG	.41829	.13854	.38120	3.019
NG	-.37059	.15513	-.30584	-2.389

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T3	.7525	.5663	.5392	20.891	.000	.5663
2	CG	.8313	.6911	.6499	16.778	.000	.1248
3	NG	.8835	.7805	.7335	16.597	.000	.0895

T3 Pretest subscore 3
CG Current grade in science
NG Ninth grade science achievement mean

Subscore 4 - Food Chains:

In this analysis two variables were identified. The pretest subscore 4 (students who scored low on the pretest made the most gains) accounted for 40 percent of the variance and the pretest subscore 7 accounted for an additional 16 percent, explaining a total of 56 percent of the variance. See Table 34 for the results.

Table 34

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 4 FOR GROUP ONE (n=29)

MULTIPLE R	.74590
R SQUARE	.55637
ADJUSTED R SQUARE	.49722
STANDARD ERROR	1.40630

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	37.20426	18.60213
RESIDUAL	15	29.66419	1.97768
F = 9.40604		SIGNIF F = .0023	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T4	-.76618	.19986	-.66110	-3.833
T7	.47121	.20402	.39830	2.310

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T4	.6314	.3986	.3610	10.605	.005	.3986
2	T7	.7459	.5564	.4972	9.406	.002	.1578

T4 Pretest subscore 4
T7 Pretest subscore 7

Subscore 5 - Food Webs:

In this analysis two variables were identified. The pretest subscore 5 (students who scored low on the pretest made the most gains) accounted for 48 percent of the variance and travel experience to Mexico (students without the experience) accounted for an additional 15 percent,

explaining a total of 63 percent of the variance. Table 35 contains these results.

Table 35

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 5 FOR GROUP ONE (n=29)

MULTIPLE R	.79229
R SQUARE	.62773
ADJUSTED R SQUARE	.57809
STANDARD ERROR	1.39177

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	48.99376	24.49688
RESIDUAL	15	29.05550	1.93703
F = 12.6466		SIGNIF F = .0006	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T5	-.80976	.17951	-.71123	-4.511
M	-1.72940	.71756	-.38991	-2.410

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T5	.6954	.4836	.4513	14.982	.001	.4836
2	M	.7923	.6277	.5781	12.647	.001	.1442

T5 Pretest subscore 5
M Travel out of the United States (Mexico)

Subscore 6 - Energy Transfer (Food):

The predictor variable identified in this analysis was the pretest subscore 6 (students who scored low on the pre-

test made the most gains). This variable accounted for 42 percent of the variance. Table 36 contains the results.

Table 36

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 6 FOR GROUP ONE (n=29)

MULTIPLE R	.65052
R SQUARE	.42317
ADJUSTED R SQUARE	.38712
STANDARD ERROR	.72791

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	6.21937	6.21937
RESIDUAL	16	8.47768	.52985
F = 11.73787		SIGNIF F = .0035	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T6	-.73897	.21569	-.65051	-3.426

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T6	.6505	.4232	.3871	11.738	.003	.4232

T6 Pretest subscore 6

Subscore 7 - Energy Pyramids:

In this analysis two predictors were identified. The pretest subscore 7 (students who scored low on the pretest

made the most gains) accounted for 33 percent of the variance and the pretest subscore 4 accounted for an additional 18 percent, explaining a total of 51 percent of the variance. Table 37 contains the results.

Table 37

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAINS SUBSCORE 7 FOR GROUP ONE (n=29)

MULTIPLE R	.71521
R SQUARE	.51152
ADJUSTED R SQUARE	.44639
STANDARD ERROR	1.20168

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	22.68193	11.34096
RESIDUAL	15	21.66043	1.44403
F = 7.85370		SIGNIF F = .0046	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T7	-.58065	.17434	-.60271	-3.331
T4	.40834	.17078	.43267	2.391

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T7	.5704	.3254	.2832	7.716	.013	.3254
2	T4	.7152	.5115	.4464	7.854	.005	.1862

T7 Pretest subscore 7
T4 Pretest subscore 4

Subscore 8 - Nutrient Cycles:

In this analysis two variables were identified. The pretest subscore 8 (students who scored low on the pretest made the most gains) accounted for 33 percent of the variance and preference for cabin facilities while in the outdoors (students who did not prefer cabin facilities) accounted for an additional 18 percent, explaining a total of 51 percent of the variance. Refer to Table 38.

Table 38

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 8 FOR GROUP ONE (n=29)

MULTIPLE R	.71508
R SQUARE	.51134
ADJUSTED R SQUARE	.44618
STANDARD ERROR	.62022

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	6.03780	3.01890
RESIDUAL	15	5.77008	.38467
F = 7.84799		SIGNIF F = .0047	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T8	-.87079	.253483	-.62441	-3.435
LX	-.70794	.299306	-.42992	-2.365

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T8	.5737	.3291	.2871	7.848	.013	.3291
2	LX	.7151	.5113	.4462	7.848	.005	.1823

T8 Pretest subscore 8
LX Preference for staying in a cabin when in the outdoors

Total Adjusted Gain Score:

In this analysis two variables were identified. The total pretest score (students who scored low on the pretest made the most gains) accounted for 41 percent of the variance and the students' positive perception of their learning in their science classes accounted for an additional 18 percent, explaining a total of 59 percent of the variance. Table 39 contains the results of this regression analysis.

Table 39

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED TOTAL SCORE FOR GROUP ONE (n=29)

MULTIPLE R	.76854
R SQUARE	.59065
ADJUSTED R SQUARE	.53607
STANDARD ERROR	3.45161

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	257.85275	128.92637
RESIDUAL	15	178.70390	11.91359
F = 10.8217		SIGNIF F = .0012	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	-.93802	.20610	-.80946	-4.551
Q	3.47638	1.34616	.45930	2.582

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.6392	.4087	.3717	11.057	.004	.4087
2	Q	.7685	.5907	.5361	10.822	.001	.1820

TTT Total Pretest Score
Q Positive Perception of Learning in Science

Adjusted Retention Gain Scores against Background, Pretest, Posttest, and Adjusted Gain Scores

Subscore 1 - Plant and Animal Characteristics:

The predictor variable identified in this analysis was the students' travel experience to Hawaii and/or Alaska. The variance accounted for by this variable was 27 percent. Refer to Table 40 for the results.

Table 40

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 1 FOR GROUP ONE (n=29)

MULTIPLE R	.51667
R SQUARE	.26694
ADJUSTED R SQUARE	.22113
STANDARD ERROR	.92913

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	5.02986	5.02986
RESIDUAL	16	13.81250	.86328

F = 5.82645 SIGNIF F = .0281

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
H	-1.55000	.64214	.51666	-2.414

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	H	.5167	.2669	.2211	5.826	.028	.2669

H Travel (Hawaii or Alaska)

Subscore 2 - Plant and Animal Identification:

In this analysis two variables were identified. The adjusted gain subscore 2 (students who scored low on the pretest made the most gains) accounted for 41 percent of the variance and the pretest subscore 2 (students who scored low on the pretest made the most gains) accounted for an additional 18 percent, explaining a total of 59 percent of the variance. Refer to Table 41.

Table 41

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 2 FOR GROUP ONE (n=29)

MULTIPLE R	.76848
R SQUARE	.59057
ADJUSTED R SQUARE	.53598
STANDARD ERROR	.39570

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	3.38777	1.69388
RESIDUAL	15	2.34868	.15658
F = 10.81809		SIGNIF F = .0012	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
AD2	-.80000	.18310	-1.22642	-4.369
T2	-.542105	.20906	-.72790	-2.593

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	AD2	.6380	.4070	.3700	10.983	.004	.4070
2	T2	.7685	.5906	.5360	10.818	.001	.1835

AD2 Adjusted gain subscore 2
T2 Pretest subscore 2

Subscore 3 - Plant and Animal Habitats:

In this analysis four variables were identified. These included: students' preference for listening to lectures in science classes (students who did not prefer lectures); the adjusted gain subscore 3 (students who scored low on the pretest made the most gains); the pretest subscore 3

(students who scored low on the pretest made the most gains); and the adjusted gain subscore 7. These variables contributed 26 percent, 20 percent, 33 percent, and 6 percent, respectively, to the variance, explaining a total of 85 percent of the variance. Refer to Table 42.

Table 42

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 3 FOR GROUP ONE (n=29)

MULTIPLE R	.92274
R SQUARE	.85145
ADJUSTED R SQUARE	.80574
STANDARD ERROR	.42018

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	4	13.15553	3.28888
RESIDUAL	13	2.29521	.17655
F = 18.62815		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
L	-.70623	.25726	-.32261	-2.745
AD3	-.98539	.14842	-1.08698	-6.629
T3	-.95579	.19193	-.81909	-4.980
AD7	.15900	.06983	.26936	2.277

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	L	.5132	.2633	.2173	5.720	.029	.2633
2	AD3	.6899	.4625	.3908	6.452	.010	.1991
3	T3	.8901	.7922	.7477	17.791	.000	.3297
4	AD7	.9227	.8514	.8057	18.628	.000	.0592

L Preference for listening to lectures in science classes
AD3 Adjusted Gain subscore 3
T3 Pretest subscore 3
AD7 Adjusted Gain subscore 7

Subscore 4 - Food Chains:

In this analysis seven variables were identified. These included: the adjusted gain subscore 8; travel experience to Hawaii or Alaska (students without the experience); preference for learning in the outdoors; the eighth grade science achievement grade; the adjusted gain subscore 1 (students who scored low on the pretest made the most gains); the pretest subscore 6 (students who scored low on the pretest made the most gains); and the adjusted gain subscore 5. These variables contributed 29 percent, 24 percent, 12 percent, 11 percent, 8 percent, 9 percent, and 4 percent, respectively, to the variance, explaining a total of 97 percent of the variance. Refer to Table 43.

Table 43

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 4 FOR GROUP ONE (n=29)

MULTIPLE R	.98610
R SQUARE	.97239
ADJUSTED R SQUARE	.95306
STANDARD ERROR	.29309

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	7	30.25180	4.32169
RESIDUAL	10	.85904	.08590
F = 50.30849		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
AD8	1.01267	.08844	.62388	11.450
H	-1.16376	.23028	-.30189	-5.054
O	2.21765	.29795	.42274	7.443
EG	1.02962	.10114	.67513	10.179
AD1	-.47644	.07270	-.43487	-6.552
T6	-.59982	.09384	-.36292	-6.392
AD5	.13139	.03660	.20811	3.589

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	AD8	.5363	.2877	.2431	6.461	.022	.2877
2	H	.7242	.5245	.4611	8.272	.004	.2368
3	O	.8081	.6530	.5787	8.782	.002	.1285
4	EG	.8731	.7622	.6891	10.419	.001	.1092
5	AD1	.9168	.8404	.7740	12.642	.000	.0784
6	T6	.9678	.9368	.9023	27.181	.000	.0964
7	AD5	.9861	.9724	.9531	50.308	.000	.0356

AD8 Adjusted Gain subscore 8
H Travel experience (Hawaii or Alaska)
O Preference for learning science in the outdoors
EG Eighth grade science achievement grade
AD1 Adjusted Gain subscore 1
T6 Pretest subscore 6
AD5 Adjusted Gain subscore 5

Subscore 5 - Food Webs:

In this analysis five variables were identified. These included: the adjusted gain total score (students who scored low on the pretest made the most gains); the cumulative science grade mean (students who had low means); travel experience to Europe (students without the experience); the pretest subscore 5 (students who scored low on the pretest made the most gains); and the adjusted gain subscore 5 (students who scored low on the pretest made the most gains). These variables contributed 30 percent, 22 percent, 14 percent, 10 percent, and 10 percent, respectively, to the variance, explaining a total of 86 percent of the variance. Table 44 contains the results.

Table 44

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 5 FOR GROUP ONE (n=29)

MULTIPLE R	.92574
R SQUARE	.85699
ADJUSTED R SQUARE	.81299
STANDARD ERROR	.84469

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	4	55.58419	13.89605
RESIDUAL	13	9.27542	.71349
F = 19.47606		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
V	-.10195	.03538	-.31617	-2.882
E	-1.62085	.49732	-.36137	-3.259
T5	-.77679	.15833	-.74844	-4.906
AD5	-.83572	.13994	-.91677	-5.972

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	ADT	.5432	.2951	.2510	6.698	.020	.2951
2	V	.7203	.5189	.4547	8.088	.004	.2238
3	E	.8142	.6630	.5908	9.181	.001	.1441
4	T5	.8728	.7618	.6885	10.395	.001	.0988
5	AD5	.9305	.8657	.8098	15.477	.000	.1039

ADT	Adjusted Gain Total Score
V	Cumulative science grade mean
E	Travel out of the United States (Europe)
T5	Pretest subscore 5
AD5	Adjusted Gain subscore 5

Subscore 6 - Energy Transfer (Food):

In this analysis two variables were identified. The students' travel experience to Hawaii or Alaska (students without the experience) accounted for 41 percent of the variance and the students' positive perception of learning that occurred in science classes (students with negative perceptions of learning) accounted for an additional 15 percent, explaining a total of 56 percent of the variance. Refer to Table 45 for the results of this regression analysis.

Table 45

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 6 FOR GROUP ONE (n=29)

MULTIPLE R	.74747
R SQUARE	.55871
ADJUSTED R SQUARE	.49988
STANDARD ERROR	.63467

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	7.64997	3.82499
RESIDUAL	15	6.04215	.40281
F = 9.49577		SIGNIF F = .0022	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
H	-1.53537	.44060	-.60037	-3.485
Q	-.52572	.23093	-.39221	-2.276

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	H	.6374	.4063	.3691	10.948	.004	.4063
2	Q	.7475	.5587	.4999	9.496	.002	.1525

H Travel experience (Hawaii or Alaska)
Q Positive Perception of Learning in Science

Subscore 7 - Energy Pyramids:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 104 in Appendix G.

Subscore 8 - Nutrient Cycles:

The predictor variable identified in this analysis was the adjusted gain subscore 8 (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 29 percent. Table 46 reports the results of this regression analysis.

Table 46

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 8 FOR GROUP ONE (n=29)

MULTIPLE R	.53600
R SQUARE	.28730
ADJUSTED R SQUARE	.24276
STANDARD ERROR	.78927

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	4.01796	4.01796
RESIDUAL	16	9.96726	.62295
F = 6.44985		SIGNIF F = .0219	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
AD8	-.58333	.22969	-.53600	-2.540

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	AD8	.5360	.2873	.2428	6.450	.022	.2873

AD8 Adjusted Gain subscore 8

Total Adjusted Retention Score:

In this analysis three variables were identified. These included: the adjusted gain total score (students who

scored low on the pretest made the most gains); the pretest total score (students who scored low on the pretest made the most gains); and preference for listening to lectures in science classes (students who do not prefer lectures). These variables contributed 44 percent, 21 percent, and 11 percent, respectively, to the variance, explaining a total of 76 percent of the variance. Table 47 contains the results of this regression.

Table 47

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED TOTAL SCORE FOR GROUP ONE (n=29)

MULTIPLE R	.87550
R SQUARE	.76650
ADJUSTED R SQUARE	.71646
STANDARD ERROR	2.51735

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	3	291.22688	97.07563
RESIDUAL	14	88.71893	6.33707
F = 15.31870		SIGNIF F = .0001	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
ADT	-1.08446	.16204	-1.16244	-6.692
TTT	-.72683	.18414	-.67232	-3.947
L	-3.78163	1.44999	-.34835	-2.608

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	ADT	.6644	.4415	.4065	12.646	.003	.4415
2	TTT	.8081	.6530	.6068	14.117	.000	.2116
3	L	.8755	.7665	.7165	15.319	.000	.1134

ADT Adjusted Gain Total score
TTT Pretest Total score
L Preference for listening to lectures in science classes

Group Two

Pretest Scores against Background Variables

Subscore 1 - Plant and Animal Characteristics:

Since no predictor emerged, a table is not included.

Subscore 2 - Plant and Animal Identification:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 105 in Appendix G.

Subscore 3 - Plant and Animal Habitats:

The predictor variable identified in this analysis was the students' cumulative grade mean (students who had a low mean made the most gains). The variance accounted for by this variable was 30 percent. Table 48 contains the analysis.

Table 48

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 3 FOR GROUP TWO (n=21)

MULTIPLE R	.55126
R SQUARE	.30388
ADJUSTED R SQUARE	.26038
STANDARD ERROR	.79178

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	4.37884	4.37884
RESIDUAL	16	10.03069	.62692
F = 6.98471		SIGNIF F = .0177	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
V	-.06365	.02408	-.55125	-2.643

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	V	.5513	.3039	.2604	6.985	.018	.3039

V Cumulative Science grade mean

Subscore 4 - Food Webs:

In this analysis four variables were identified. These included: the students' previous science grade mean; the cumulative science grade mean (students who had a low mean made the most gains); viewing of science television programs; and preference for staying in a motel while explor-

ing the outdoors. These variables contributed 34 percent, 28 percent, 17 percent, and 18 percent, respectively, to the variance, explaining a total of 97 percent of the variance. Table 49 contains the results of this regression analysis.

Table 49

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 4 FOR GROUP TWO (n=21)

MULTIPLE R	.98869
R SQUARE	.97750
ADJUSTED R SQUARE	.97058
STANDARD ERROR	.26361

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	4	39.24899	9.81225
RESIDUAL	13	.90339	.06949

F = 141.20124 SIGNIF F = .0000

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
PG	4.52060	.24822	2.86302	18.212
V	-.49250	.03033	-2.55526	-16.235
WV	2.51162	.19766	.58599	12.706
LW	3.09347	.29930	.80992	10.336

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	PG	.5845	.3416	.3005	8.302	.011	.3416
2	V	.7869	.6193	.5685	12.199	.001	.2777
3	WV	.8903	.7926	.7482	17.837	.000	.1734
4	LW	.9887	.9775	.9705	141.201	.000	.1849

PG Previous science grade average
V Cumulative science grade mean
WV Watched science television programs
LW Preference for staying in motels while traveling

Subscore 5 - Food Webs:

Since no predictor emerged, a table is not included.

Subscore 6 - Energy Transfer (Food):

In this analysis two variables were identified. The desire to take additional science classes accounted for 38 percent of the variance and the students' experience in hiking in the outdoors accounted for an additional 14 percent, explaining a total of 52 percent of the variance. Table 50 contains the results.

Table 50

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 6 FOR GROUP TWO (n=21)

MULTIPLE R	.72118
R SQUARE	.52010
ADJUSTED R SQUARE	.46364
STANDARD ERROR	.43813

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	3.53667	1.76833
RESIDUAL	17	3.26333	.19196
F = 9.21197		SIGNIF F = .0019	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
MM	.43938	.11637	.63505	3.776
HO	.73999	.33451	.37206	2.212

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	MM	.6180	.3820	.3476	11.124	.004	.3820
2	HO	.7212	.5201	.4636	9.212	.002	.1381

MM Desire to take additional science classes
HO Hiked outdoors

Subscore 7 - Energy Pyramids:

Since no predictor emerged, a table is not included.

Subscore 8 - Nutrient Cycles:

In this analysis two variables were identified. The students' experience in making trips that were more that 50 miles away yearly accounted for 21 percent of the variance and the students' positive perception that they had learned in their science classes accounted for an additional 17 percent, explaining a total of 38 percent of the variance. Refer to Table 51 for the results.

Table 51

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 8 FOR GROUP TWO (n=21)

MULTIPLE R	.61534
R SQUARE	.37865
ADJUSTED R SQUARE	.30555
STANDARD ERROR	.71533

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	5.30106	2.65053
RESIDUAL	17	8.69894	.51170
F = 5.17983		SIGNIF F = .0175	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TM	.54082	.21026	.49677	2.588
Q	.70976	.33118	.41145	2.143

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TM	.4591	.2108	.1669	4.807	.042	.2108
2	Q	.6153	.3786	.3055	5.180	.018	.1679

TM Made trips that were a distance of 50 miles or more
Q Positive Perception of Learning in Science

Total Pretest Score:

The predictor variable that was identified in this analysis was the students' expression of wanting to watch science-related television programs. This variable accounted for 28 percent of the variance. Table 52 contains the results.

Table 52

REGRESSION OF BACKGROUND VARIABLES ON PRETEST TOTAL SCORE FOR GROUP TWO (n=21)

MULTIPLE R	.53224
R SQUARE	.28327
ADJUSTED R SQUARE	.23848
STANDARD ERROR	5.14896

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	167.65422	167.65422
RESIDUAL	16	424.18864	26.51179
F = 6.32376		SIGNIF F = .0230	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TV	6.13636	2.44018	.53223	2.515

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TV	.5322	.2833	.2385	6.324	.023	.2833

TV Watch science television programs (prefer)

Posttest Scores against Background and Pretest Scores

Subscore 1 - Plant and Animal Characteristics:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 106 in Appendix G.

Subscores 2 through 4:

Since no predictors emerged, no tables are included.

Subscore 5 - Food Webs:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 107 in Appendix G.

Subscore 6 - Energy Transfer (Food):

The predictor variable identified in this analysis was the indication of the students' sex (male students scored low on the pretest and made the most gains). This variable accounted for 44 percent of the variance. Table 53 presents the results.

Table 53

REGRESSION OF BACKGROUND AND PRETEST SCORES ON SUBSCORE 6 FOR GROUP TWO (n=21)

MULTIPLE R	.66332
R SQUARE	.44000
ADJUSTED R SQUARE	.37000
STANDARD ERROR	.36742

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	.84857	.84857
RESIDUAL	8	1.08000	.13500
F = 6.28571		SIGNIF F = .0365	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
SX	-.60000	.23931	-.66332	-2.507

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	SX	.6633	.4400	.3700	6.286	.037	.4400

SX Students' sex

Subscore 7 - Energy Pyramids:

The predictor variable identified in this analysis was the total score of the pretest. This variable accounted for 58 percent of the variance. Table 54 presents the results of this regression.

Table 54

REGRESSION OF BACKGROUND AND PRETEST SCORES ON SUBSCORE 7 FOR GROUP TWO (n=21)

MULTIPLE R	.75841
R SQUARE	.57519
ADJUSTED R SQUARE	.52208
STANDARD ERROR	.61464

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	4.09203	4.09203
RESIDUAL	8	3.02225	.37778
F = 10.8317		SIGNIF F = .0110	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	.11428	.03472	.75841	3.291

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.7584	.5722	.5221	10.832	.011	.5752

TTT Total Pretest score

Subscore 8 - Nutrient Cycles:

The predictor variable identified by this analysis was the students' positive expression of enjoyment with their science classes. This variable accounted for 65 percent of the variance. Table 55 presents the results.

Table 55

REGRESSION OF BACKGROUND AND PRETEST SCORES ON SUBSCORE 8 FOR GROUP TWO (n=21)

MULTIPLE R	.80645
R SQUARE	.65036
ADJUSTED R SQUARE	.60666
STANDARD ERROR	.48193

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	3.45622	3.45622
RESIDUAL	8	1.85806	.23226
F = 14.88095		SIGNIF F = .0048	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
EJ	.80645	.20905	.80645	3.858

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	EJ	.8065	.6504	.6067	14.881	.005	.6504

EJ Enjoyment of Science Classes

Total Score:

The predictor variable identified in this analysis was the students' expression that they enjoyed their science classes. This variable accounted for 66 percent of the variance. Table 56 presents the results of this regression.

Table 56

REGRESSION OF BACKGROUND AND PRETEST SCORES ON TOTAL SCORE FOR GROUP TWO (n=21)

MULTIPLE R	.81301
R SQUARE	.66226
ADJUSTED R SQUARE	.62005
STANDARD ERROR	1.70621

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	45.66783	45.66783
RESIDUAL	8	23.28931	2.91116
F = 15.68714		SIGNIF F = .0042	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
EJ	2.931452	.74013	.81379	3.961

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	EJ	.8138	.6623	.6200	15.687	.004	.6623

EJ Enjoyment of Science Classes

Adjusted Gain Scores against Background and Pretest Scores.

Subscore 1 - Plant and Animal Characteristics:

The predictor variable identified in this analysis was the pretest subscore 1 (students who scored low on the pre-test made the most gains). This variable accounted for 43 percent of the variance. Table 57 contains the results.

Table 57

REGRESSION OF BACKGROUND AND PRETEST RESULTS ON ADJUSTED GAIN SUBSCORE 1 FOR GROUP TWO (n=21)

MULTIPLE R	.65920
R SQUARE	.43454
ADJUSTED R SQUARE	.36386
STANDARD ERROR	.57987

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2.06719	2.06719
RESIDUAL	8	2.68996	.33624
F = 6.14787		SIGNIF F = .0381	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T1	-.65625	.26467	-.65919	-2.479

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T1	.6592	.4345	.3639	6.148	.038	.4345

T1 Pretest subscore 1

Subscore 2 - Plant and Animal Identification:

In this analysis three predictor variables were identified. These included: the pretest subscore 2 (students who scored low on the pretest made the most gains); travel experience to South America (students without the experience); and preference for laboratory activities. These

variables contributed to 81 percent, 9 percent, and 6 percent, respectively, to the variance, explaining a total of 96 percent of the variance. Table 58 presents the results of this regression analysis.

Table 58

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 2 FOR GROUP TWO (n=21)

MULTIPLE R	.98109
R SQUARE	.96253
ADJUSTED R SQUARE	.94379
STANDARD ERROR	.16113

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	3	4.00137	1.33379
RESIDUAL	6	.15577	.02596
F = 51.37566		SIGNIF F = .0001	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T2	-1.15384	.09421	-1.13586	-12.247
S	-1.23076	.28437	-.39517	-4.328
D	.57692	.18512	.25533	3.116

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T2	.9006	.8111	.7875	34.360	.000	.8111
2	S	.9497	.9019	.8738	32.169	.000	.0907
3	D	.9625	.9438	.9438	51.376	.000	.0607

T2 Pretest subscore 2
S Traveled out of the United States (South America)
D Preference for doing laboratory activities in science

Subscore 3 - Plant and Animal Habitats:

The predictor variable identified in this analysis was the pretest subscore 3 (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 58 percent. Refer to Table 59 for the results.

Table 59

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 3 FOR GROUP TWO (n=21)

MULTIPLE R	.76188
R SQUARE	.58045
ADJUSTED R SQUARE	.52801
STANDARD ERROR	.64830

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	4.65193	4.65193
RESIDUAL	8	3.36236	.42029
F = 11.06824		SIGNIF F = .0104	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T3	-.78089	.23472	-.76187	-3.327

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T3	.7619	.5805	.5280	11.068	.010	.5805

T3 Pretest subscore 3

Subscore 4 - Food Chains:

In this analysis three predictor variables were identified. These included: the pretest subscore 4 (students who scored low on the pretest made the most gains); the ninth grade average science grade; and the previous science grade mean (students who scored low on the pretest made the most gains). These variables contributed to 67 percent, 18 percent, and 8 percent, respectively, to the variance, explaining a total of 93 percent of the variance. Refer to Table 60 for the results.

Table 60

'REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 4 FOR GROUP TWO (n=21)

MULTIPLE R	.96495
R SQUARE	.93113
ADJUSTED R SQUARE	.89670
STANDARD ERROR	.48743

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	3	19.27449	6.42482
RESIDUAL	6	1.42551	.23758
F = 27.04227		SIGNIF F = .0007	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T4	-.81651	.13138	-.82659	-6.215
NG	1.04696	.22363	.81272	4.682
PG	-.83452	.30584	-.53559	-2.729

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T4	.8160	.6659	.6241	15.943	.004	.6659
2	NG	.9196	.8457	.8016	19.180	.001	.1798
3	PG	.9650	.9311	.8967	27.042	.001	.0855

T4 Pretest subscore 4
NG Ninth grade science achievement grade
PG Previous science achievement grade

Subscore 5 - Food Webs:

The predictor variable identified in this analysis was the pretest subscore 5 (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 79 percent. Table 61 contains the results of this regression.

Table 61

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 5 FOR GROUP TWO (n=21)

MULTIPLE R	.89116
R SQUARE	.79416
ADJUSTED R SQUARE	.76843
STANDARD ERROR	1.39864

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	60.37897	60.37897
RESIDUAL	8	15.64960	1.95620
F = 30.86544		SIGNIF F = .0005	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T5	-1.58170	.28470	-.89115	-5.556

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T5	.8912	.7942	.7684	30.865	.001	.7942

T5 Pretest subscore 5

Subscore 6:

The predictor variable identified in this analysis was the pretest total score (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 63 percent. Refer to Table 62 for the results.

Table 62

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 6 FOR GROUP TWO (n=21)

MULTIPLE R	.79429
R SQUARE	.63090
ADJUSTED R SQUARE	.58476
STANDARD ERROR	.40267

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2.21716	2.21716
RESIDUAL	8	1.29713	.16214
F = 13.67426		SIGNIF F = .0061	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	-.08412	.02274	-.79429	-3.698

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.7943	.6309	.5848	13.674	.006	.6309

TTT Pretest Total score

Subscore 7 - Energy Pyramids:

In this analysis two predictor variables were identified. The pretest subscore 7 (students who scored low on the pretest made the most gains) accounted for 98 percent of the variance and the pretest subscore 1 (students who scored low on the pretest made the most gains) accounted

for an additional 1 percent of the variance, explaining a total of 99 percent of the variance. Refer to Table 63 for the results.

Table 63

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 7 FOR GROUP TWO (n=21)

MULTIPLE R	.99718
R SQUARE	.99436
ADJUSTED R SQUARE	.99275
STANDARD ERROR	.14620

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	26.37896	13.18948
RESIDUAL	7	.14961	.02137
F = 617.10971		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T7	-1.00413	.02870	-1.01257	-34.978
T1	-.24912	.06805	-.10596	-3.661

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T7	.9917	.9836	.9815	478.759	.000	.9836
2	T1	.9972	.9944	.9927	617.110	.000	.0108

T7 Pretest subscore 7
T1 Pretest subscore 1

Subscore 8 - Nutrient Cycles:

The predictor variable identified in this analysis was the students' seventh grade science achievement grade. The variance accounted for by this variable was 41 percent. The results are presented in Table 64.

Table 64

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 8 FOR GROUP TWO (n=21)

MULTIPLE R	.64385
R SQUARE	.41454
ADJUSTED R SQUARE	.34136
STANDARD ERROR	.69498

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2.73597	2.73597
RESIDUAL	8	3.86403	.48300
F = 5.66449		SIGNIF F = .0445	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
SG	.649517	.27290	.64384	2.380

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	SG	.6438	.4145	.3414	5.664	.045	.4145

SG Seventh grade science achievement grade

Total Adjusted Gain Score:

In this analysis two predictor variables were identified. The pretest total score (students who scored low on

the pretest made the most gains) accounted for 78 percent of the variance and the students' expression of enjoyment of their science classes accounted for an additional 13 percent of the variance, explaining a total of 91 percent of the variance. Refer to Table 65 for the results.

Table 65

REGRESSION OF BACKGROUND AND PRETEST SCORES ON TOTAL ADJUSTED SCORE FOR GROUP TWO (n=21)

MULTIPLE R	.95547
R SQUARE	.91293
ADJUSTED R SQUARE	.88805
STANDARD ERROR	1.62753

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	194.41523	97.20762
RESIDUAL	7	18.54191	2.64884
F = 36.69812		SIGNIF F = .0002	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	-.86475	.10104	-1.04892	-8.560
EJ	2.50117	.77571	.39511	3.224

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.8852	.7836	.7566	28.972	.001	.7836
2	EJ	.9555	.9129	.8881	36.698	.000	.1293

TTT Pretest Total score
EJ Enjoyment of Science classes

Adjusted Retention Gain Scores against Background, Pretest, Posttest, and Adjusted Gain Scores

Subscore 1 - Plant and Animal Characteristics:

Since no predictor emerged, a table is not included.

Subscore 2 - Plant and Animal Identification:

The predictor variable identified in this analysis was the students' positive attitudes toward taking nature hikes. The variance accounted for by this variable was 48 percent. Refer to Table 66 for the results.

Table 66

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 2 FOR GROUP TWO (n=21)

MULTIPLE R	.68920
R SQUARE	.47500
ADJUSTED R SQUARE	.40938
STANDARD ERROR	.16771

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	.20357	.20357
RESIDUAL	8	.22500	.02812
F = 7.23810		SIGNIF F = .0275	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
NH	.50000	.18584	.68920	2.690

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	NH*	.6892	.4750	.4094	7.238	.027	.4750

NH Desire to take nature hikes

Subscore 3 - Plant and Animal Habitats:

Since no predictor variable was identified, no table is included.

Subscore 4 - Food Chains:

Since no predictor variable was identified, no table is included.

Subscore 5 - Food Webs:

The predictor variable identified was the adjusted gain score 5 (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 42 percent. Refer to Table 67 for the results of this regression analysis.

Table 67

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 5 FOR GROUP TWO (n=21)

MULTIPLE R	.64539
R SQUARE	.41782
ADJUSTED R SQUARE	.34505
STANDARD ERROR	.93948

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	5.06758	5.06758
RESIDUAL	8	7.06099	.88262

F = 5.74149 SIGNIF F = .0434

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
AD5	-.25817	.10774	-.64639	-2.396

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	AD5	.6464	.4178	.3450	5.741	.043	.4178

AD5 Adjusted Gain subscore 5

Subscore 6 - Energy Transfer (Food):

In this analysis two variables were identified. The students' travel experience to South America (students without the experience) accounted for 65 percent of the variance and the adjusted gain subscore 6 (students who scored low on the pretest made the most gains) accounted for an additional 18 percent of the variance, explaining a total of 83 percent of the variance. Table 68 reports these results.

Table 68

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 6 FOR GROUP TWO (n=21)

MULTIPLE R	.91411
R SQUARE	.83561
ADJUSTED R SQUARE	.78864
STANDARD ERROR	.23528

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	1.96964	.98482
RESIDUAL	7	.38750	.05536
F = 17.79032		SIGNIF F = .0018	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
S	-1.61111	.37430	-.68698	-4.304
AD6	-.36111	.13071	-.44092	-2.763

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	S	.8102	.6564	.6134	15.280	.004	.6564
2	AD6	.9141	.8356	.7886	17.790	.002	.1792

S Travel experience (South America)
AD6 Adjusted Gain score 6

Subscore 7 - Energy Pyramids:

The predictor variable identified in this analysis was the adjusted gain subscore 5. The variance accounted for by this variable was 48 percent. Table 69 reports the results of this regression analysis.

Table 69

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 7 FOR GROUP TWO (n=21)

MULTIPLE R	.68960
R SQUARE	.47555
ADJUSTED R SQUARE	.40999
STANDARD ERROR	1.19350

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	4.01796	4.01796
RESIDUAL	8	9.96726	.62295
F = 7.25400		SIGNIF F = .0274	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
AD5	.36865	.13687	.68960	2.693

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	AD5	.6896	.4755	.4100	7.254	.027	.4755

AD5 Adjusted Gain subscore 5

Subscore 8 and Total Adjusted Retention score:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level

because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 108 in the Appendix G.

Group Three

Pretest Scores against Background Variables

Subscore 1 - Plant and Animal Characteristics:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 109 in Appendix G.

Subscore 2 - Plant and Animal Identification:

The predictor variable identified in this analysis was the students' travel experience to South America (students without the experience). The variance accounted for by this variable was 27 percent. Refer to Table 70 for the results.

Table 70

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 2 FOR GROUP THREE (n=29)

MULTIPLE R	.51675
R SQUARE	.26653
ADJUSTED R SQUARE	.23832
STANDARD ERROR	.63362

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	3.79313	3.79313
RESIDUAL	26	10.43839	.40148
F = 9.44796		SIGNIF F = .0049	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
S	-.97500	.31720	-.51626	-3.074

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	S	.5163	.2665	.2383	9.448	.005	.2665

S Travel out of the United States (South America)

Subscore 3 - Plant and Animal Habitats:

The predictor variable that emerged in this analysis was the students' eleventh grade science achievement mean (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 29 percent. Table 71 presents the results.

Table 71

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 3 FOR GROUP THREE (n=29)

MULTIPLE R	.54265
R SQUARE	.29447
ADJUSTED R SQUARE	.25528
STANDARD ERROR	.40631

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1.24027	1.24027
RESIDUAL	18	2.97155	.16509
F = 7.51287		SIGNIF F = .0134	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
EZ	-.28803	.10508	-.54265	-2.741

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	EZ	.5427	.2945	.2553	7.513	.013	.2945

EZ Eleventh grade science achievement mean

Subscore 4 - Food Chains:

The predictor variable identified in this analysis was the students' positive perception that they did learn in their science classes. The variance accounted for by this variable was 15 percent. Refer to Table 72 for the results.

Table 72

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 4 FOR GROUP THREE (n=29)

MULTIPLE R	.38369
R SQUARE	.14722
ADJUSTED R SQUARE	.11442
STANDARD ERROR	.47857

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1.02798	1.02798
RESIDUAL	26	5.95478	.22903
F = 4.48842		SIGNIF F = .0438	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
Q	.44805	.211486	.38368	2.119

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	Q	.3837	.1472	.1144	4.488	.044	.1472

Q Perception of Learning in Science

Subscore 5 - Food Webs:

The predictor variable identified in this analysis was the students' desire to take additional science classes. The variance accounted for by this variable was 14 percent. Refer to Table 73 for the results.

Table 73

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 5 FOR GROUP THREE (n=29)

MULTIPLE R	.37513
R SQUARE	.14072
ADJUSTED R SQUARE	.10767
STANDARD ERROR	1.53424

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	10.02261	10.02261
RESIDUAL	26	61.20153	2.35391
F = 4.25786		SIGNIF F = .0492	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
MM	.67496	.32710	.37512	2.063

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	MM	.3751	.1407	.1077	4.258	.049	.1407

MM Desire to take additional science classes

Subscore 6 - Energy Transfer (Food):

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 110 in Appendix G.

Subscore 7 - Energy Pyramids:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 111 in Appendix G.

Subscore 8 - Nutrient Cycles:

The predictor variable identified in this analysis was the students' travel experience to Canada. The variance accounted for by this variable was 29 percent. Refer to Table 74 for the results of this analysis.

Table 74

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 8 FOR GROUP THREE (n=29)

MULTIPLE R	.53933
R SQUARE	.29088
ADJUSTED R SQUARE	.24917
STANDARD ERROR	.58492

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2.38581	2.38581
RESIDUAL	17	5.81617	.34213
F = 6.97344		SIGNIF F = .0172	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
C	.75263	.28500	.53933	2.641

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	C	.5393	.2909	.2492	6.973	.017	.2909

C Travel out of the United States (Canada)

Total Score:

The predictor variable identified in this analysis was the students' ninth grade science achievement grade. The variance accounted for by this variable was 44 percent. Table 75 contains the results of this analysis.

Table 75

REGRESSION OF BACKGROUND VARIABLES ON PRETEST TOTAL SCORE FOR GROUP THREE (n=29)

MULTIPLE R	.66427
R SQUARE	.44125
ADJUSTED R SQUARE	.39469
STANDARD ERROR	4.24665

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	170.90152	170.90152
RESIDUAL	12	216.40882	18.03407
F = 9.47659		SIGNIF F = .0096	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	4.62197	1.50141	.66426	3.078

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.6643	.4413	.3947	9.477	.010	.4413

TTT Pretest total score

Posttest Scores Against Background and Pretest Scores

Subscores 1 and 2:

Since no predictor variables emerged in these analyses, tables are not included.

Subscore 3 - Plant and Animal Habitats:

In this analysis two variables were identified. The students' eleventh grade science achievement mean (students

who had low means made the most gains) accounted for 29 percent of the variance and the students' preference for staying in a tent while in the outdoors (students who did not prefer tents) accounted for an additional 21 percent, explaining a total of 50 percent of the variance. Refer to Table 76 for the results.

Table 76

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 3 FOR GROUP THREE (n=29)

MULTIPLE R	.70699
R SQUARE	.49983
ADJUSTED R SQUARE	.43731
STANDARD ERROR	.35318

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	1.99441	.99720
RESIDUAL	16	1.99574	.12473
F = 7.99467		SIGNIF F = .0039	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
EZ	-.25416	.09477	-.47884	-2.682
LZ	-.43634	.17024	-.45763	-2.563

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	EZ	.5427	.2945	.2530	7.095	.016	.2945
2	LZ	.7070	.4373	.4373	7.995	.004	.2054

EZ Eleventh grade science achievement mean
LZ Preference to stay in tent while traveling

Subscore 4 - Food Chains:

The predictor variable identified in this analysis was the students' cumulative science achievement mean (students who had low means made the most gains). The variance accounted for by this variable was 24 percent. Table 77 contains the results of this analysis.

Table 77

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 4 FOR GROUP THREE (n=29)

MULTIPLE R	.48805
R SQUARE	.23820
ADJUSTED R SQUARE	.19338
STANDARD ERROR	.45674

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1.10884	1.10884
RESIDUAL	17	3.54633	.20861
F = 5.31543		SIGNIF F = .0340	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
V	-.04147	.01798	-.48805	-2.306

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	V	.4881	.2382	.1934	5.315	.034	.2382

V Cumulative science achievement mean

Subscore 5 - Food Webs:

The predictor variable identified in this analysis was the total pretest score. The variance accounted for by this variable was 37 percent. Refer to Table 78 for the results.

Table 78

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 5 FOR GROUP THREE (n=29)

MULTIPLE R	.60962
R SQUARE	.37163
ADJUSTED R SQUARE	.33467
STANDARD ERROR	.62974

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	3.98725	3.98725
RESIDUAL	17	6.74182	.39658
F = 10.05415		SIGNIF F = .0056	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	.08622	.02719	.60961	3.171

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.6096	.3716	.3347	10.054	.006	.3716

TTT Pretest Total score

Subscore 6 - Energy Transfer (Food):

The predictor variable identified in this analysis was the students' preference for doing outdoor investigation in their science classes. The variance accounted for by this variable was 23 percent. Table 79 contains the results.

Table 79

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 6 FOR GROUP THREE (n=29)

MULTIPLE R	.47546
R SQUARE	.22606
ADJUSTED R SQUARE	.18053
STANDARD ERROR	.60609

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	1.82407	1.32407
RESIDUAL	17	6.24490	.36735
F = 4.96552		SIGNIF F = .0396	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
O	1.71428	.76930	.47545	2.223

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	O	.4755	.2261	.1805	4.966	.040	.2261

O Prefer outdoor investigations in science classes

Subscore 7 - Energy Pyramids:

Since no variable emerged in this analysis, a table is not included.

Subscore 8 - Nutrient Cycles:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 112 in the Appendix G.

Total Score:

The predictor variable identified in this analysis was the pretest total score. The variance accounted for by this variable was 35 percent. The results of this regression are presented in Table 80.

Table 80

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST TOTAL SCORE FOR GROUP THREE (n=29)

MULTIPLE R	.59018
R SQUARE	.34831
ADJUSTED R SQUARE	.30997
STANDARD ERROR	1.67612

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	25.52604	25.52604
RESIDUAL	17	47.75967	2.80939

F = 9.08596 SIGNIF F = .0078

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	.21817	.07237	.59017	3.014

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.5902	.3483	.3100	9.086	.008	.3483

TTT Pretest Total score

Adjusted Gain Scores against Background and Pretest Scores

Subscore 1 - Plant and Animal Characteristics:

In this analysis two variables were identified. The pretest subscore 1 (students who scored low on the pretest made the most gains) accounted for 61 percent of the variance and the students' travel experience to Canada (students without the experience) accounted for an additional

11 percent, explaining a total of 72 percent of the variance. Refer to Table 81 for the results.

Table 81

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 1 FOR GROUP THREE (n=29)

MULTIPLE R	.85034
R SQUARE	.72308
ADJUSTED R SQUARE	.68847
STANDARD ERROR	.50625

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	10.70733	5.35366
RESIDUAL	16	4.10055	.25628
F = 20.8895		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T1	-1.05825	.16460	-.88577	-6.429
C	-1.71359	.67294	-.35083	-2.546

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T1	.7816	.6109	.5880	26.686	.000	.6109
2	C	.8503	.7231	.6885	20.890	.000	.1122

T1 Pretest Subscore 1
C Travel out of the United States (Canada)

Subscore 2 - Plant and Animal Identification:

In this analysis four variables were identified. These included: the pretest subscore 2 (students who scored low

on the pretest made the most gains); preference for working in groups in science classes; the total years of science classes taken at the secondary level; and preference for listening to lectures in science classes. These variables contributed 93 percent, 2 percent, 1 percent, and 1 percent, respectively, to the variance, explaining a total of 97 percent of the variance. Table 82 contains the results.

Table 82

REGRESSION OF BACKGROUND AND PRETEST RESULTS ON ADJUSTED GAIN SUBSCORE 2 FOR GROUP THREE (n=29)

MULTIPLE R	.98764
R SQUARE	.97544
ADJUSTED R SQUARE	.96842
STANDARD ERROR	.13140

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	4	9.60065	2.40016
RESIDUAL	14	.24172	.01727
F = 139.01457		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T2	-.97579	.04350	-.958048	-22.431
W	.43240	.10858	.181237	3.982
TT	.08325	.03221	.109260	2.584
L	.17768	.08211	.099060	2.164

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T2	.9681	.9371	.9334	253.384	.000	.9371
2	W	.9780	.9565	.9510	175.724	.000	.0193
3	TT	.9835	.9672	.9607	147.570	.000	.0108
4	L	.9876	.9754	.9684	139.015	.000	.0082

T2 Pretest subscore 2
W Preference for working in groups in science classes
TT Total years of science (at secondary level)
L Preference for listening to lectures in science classes

Subscore 3 - Plant and Animal Habitats:

Three variables were identified in this analysis. These included: the pretest subscore 3 (students who scored low on the pretest made the most gains); the eleventh grade science achievement mean (students with low means made the

most gains); and preference for staying in tents while exploring the outdoors (students who did not prefer tents). These variables contributed 77 percent, 6 percent, and 5 percent, respectively, to the variance, explaining a total of 88 percent of the variance. Refer to Table 83 for the results.

Table 83

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 3 FOR GROUP THREE (n=29)

MULTIPLE R	.93925
R SQUARE	.88219
ADJUSTED R SQUARE	.85863
STANDARD ERROR	.36803

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	3	15.21458	5.07153
RESIDUAL	15	2.03173	.13545
F = 37.44249		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T3	-1.01290	.10313	-.87154	-9.821
EZ	-.24811	.09886	-.22484	-2.510
LZ	-.43831	.17746	-.22111	-2.470

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T3	.8769	.7689	.7553	56.564	.000	.7689
2	EZ	.9134	.8343	.8136	40.276	.000	.0654
3	LZ	.9393	.8822	.8586	37.442	.000	.0479

T3 Pretest subscore 3
EZ Eleventh grade science achievement mean
LZ Preference for staying in tents while traveling

Subscore 4 - Food Chains:

In this analysis two variables were identified. The pretest subscore 4 (students who scored low on the pretest made the most gains) accounted for 92 percent of the variance and the students' cumulative science grade mean (students with low means made the most gains) accounted for an additional 2 percent, explaining a total of 94 percent of the variance. Refer to Table 84 for the results.

Table 84

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 4 FOR GROUP THREE (n=29)

MULTIPLE R	.97105
R SQUARE	.94295
ADJUSTED R SQUARE	.93581
STANDARD ERROR	.46129

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	56.27019	28.13510
RESIDUAL	16	3.40406	.21279
F = 132.21838		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T4	-.92723	.06097	-.93033	-15.208
V	-.04315	.01861	-.14185	-2.319

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T4	.9611	.9238	.9193	206.017	.000	.9238
2	V	.9711	.9358	.9358	132.218	.000	.0192

T4 Pretest subscore 4
V Cumulative Science grade mean

Subscore 5 - Food Webs:

In this analysis two variables were identified. The pretest subscore 5 (students who scored low on the pretest made the most gains) accounted for 76 percent of the variance and the pretest subscore 3 accounted for an additional 7 percent, explaining a total of 83 percent of the variance. Table 85 contains the results.

Table 85

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 5 FOR GROUP THREE (n=29)

MULTIPLE R	.90864
R SQUARE	.82563
ADJUSTED R SQUARE	.80383
STANDARD ERROR	.62637

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	29.72252	14.86126
RESIDUAL	16	6.27774	.39234
F = 37.87828		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T5	-.83963	.09667	-.92990	-8.685
T3	.44762	.17978	.26658	2.490

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T5	.8707	.7581	.7438	53.268	.000	.7581
2	T3	.9086	.8023	.8038	37.878	.000	.0676

T5 Pretest subscore 5
T3 Pretest subscore 3

Subscore 6 - Energy Transfer (Food):

The predictor variable identified in this analysis was the pretest subscore 6 (students who scored low on the pretest made the most gains). This variable accounted for 33 percent of the variance. Table 86 contains the results.

Table 86

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SUBSCORE 6 FOR GROUP THREE (n=29)

MULTIPLE R	.57797
R SQUARE	.33405
ADJUSTED R SQUARE	.29488
STANDARD ERROR	.63065

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	3.39152	3.39152
RESIDUAL	17	6.76119	.39772
F = 8.52745		SIGNIF F = .0095	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T6	-.61691	.21125	-.57797	-2.920

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T6	.5780	.3341	.2949	8.527	.010	.3341

T6 Pretest subscore 6

Subscore 7 - Energy Pyramids:

In this analysis two predictors were identified. The pretest subscore 7 (students who scored low on the pretest made the most gains) accounted for 91 percent of the variance and preference for staying in travel trailers while exploring the outdoors (students who did not prefer travel

trailers) accounted for an additional 3 percent, explaining a total of 94 percent of the variance. Table 87 contains the results.

Table 87

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAINS SCORE 7 FOR GROUP THREE (n=29)

MULTIPLE R	.96841
R SQUARE	.93782
ADJUSTED R SQUARE	.93005
STANDARD ERROR	.48708

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	2	57.25325	28.62662
RESIDUAL	16	3.79602	.23725
F = 120.65967		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T7	-.92023	.05923	-.98229	-15.534
LZ	-1.21289	.45158	-.16983	-2.686

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T7	.9538	.9098	.9094	171.440	.000	.9098
2	LZ	.9684	.9378	.9300	120.660	.000	.0280

T7 Pretest subscore 7
LZ Preference for staying in travel trailers

Subscore 8 - Nutrient Cycles:

The predictor variable identified in this regression was the pretest subscore 8 (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 75 percent. The results to this analysis are found in Table 88.

Table 88

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED GAIN SCORE 8 FOR GROUP THREE (n=29)

MULTIPLE R	.86542
R SQUARE	.74895
ADJUSTED R SQUARE	.73419
STANDARD ERROR	.49018

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	12.18619	12.18619
RESIDUAL	17	4.08475	.24028
F = 50.71675		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T8	-1.21891	.177115	-.86542	-7.122

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T8	.8654	.7490	.7342	50.717	.000	.7490

T8 Pretest subscore 8

Total Adjusted Gain Score:

The predictor variable identified in this analysis was the pretest total score (students who scored low on the pretest made the most gains). The variance accounted for by this variable was 86 percent. The results are presented in Table 89.

Table 89

REGRESSION OF BACKGROUND AND PRETEST SCORES ON ADJUSTED TOTAL SCORE FOR GROUP ONE (n=29)

MULTIPLE R	.92693
R SQUARE	.85921
ADJUSTED R SQUARE	.85092
STANDARD ERROR	1.82080

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	343.94048	343.94048
RESIDUAL	17	56.36001	3.31529
F = 103.74357		SIGNIF F = .0000	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
TTT	-.80084	.07862	-.92693	-10.185

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	TTT	.9269	.8592	.8509	103.744	.000	.8592

TTT Total Pretest Score

Adjusted Retention Gain Scores against Background, Pretest, Posttest, and Adjusted Gain Scores

Subscore 1 - Plant and Animal Characteristics:

The predictor variable identified in this analysis was the adjusted gain subscore 5. The variance accounted for by this variable was 23 percent. Table 90 contains the results of this analysis.

Table 90

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 1 FOR GROUP THREE (n=29)

MULTIPLE R	.48360
R SQUARE	.23387
ADJUSTED R SQUARE	.18880
STANDARD ERROR	.65846

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2.25000	2.25000
RESIDUAL	17	7.37069	.43357
F = 5.18947		SIGNIF F = .0359	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
AD5	.25000	.10974	.48360	2.278

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	AD5	.4836	.2339	.1888	5.189	.036	.2339

AD5 Adjusted Gain subscore 5

Subscore 2 - Plant and Animal Identification:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 113 in Appendix G.

Subscore 3 - Plant and Animal Habitats:

The predictor variable identified was the pretest subscore 1 (students who scored low on the pretest made the most gains). This variable accounted for 25 percent of the variance. Refer to Table 91 for the results.

Table 91

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 3 FOR GROUP THREE (n=29)

MULTIPLE R	.49623
R SQUARE	.24624
ADJUSTED R SQUARE	.20190
STANDARD ERROR	.61913

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	1	2.12884	2.12884
RESIDUAL	17	6.51648	.38332
F = 5.55364		SIGNIF F = .0307	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
T1	-.45299	.19222	-.49622	-2.357

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	T1	.4962	.2462	.2019	5.554	.031	.2462

T1 Pretest subscore 1

Subscore 4 - Food Chains:

In this analysis four variables were identified. These included: the adjusted gain subscore 7 (students who scored low on the pretest made the most gains); the pretest subscore 8 (students who scored low on the pretest made the most gains); the cumulative science grade mean; and preference for listening to lectures in science classes. These variables contributed to 26 percent, 17 percent, 21 per-

cent, and 9 percent, respectively, to the variance, explaining a total of 73 percent of the variance. Table 92 reports these results.

Table 92

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON RETENTION ADJUSTED SUBSCORE 4 FOR GROUP THREE (n=29)

MULTIPLE R	.85649
R SQUARE	.73357
ADJUSTED R SQUARE	.65745
STANDARD ERROR	.42393

ANALYSIS OF VARIANCE

	DF	SUM OF SQUARES	MEAN SQUARE
REGRESSION	4	6.92735	1.73184
RESIDUAL	14	2.51600	.17971
F = 9.63663		SIGNIF F = .0006	

VARIABLES IN THE EQUATION

VARIABLE	B	SE B	BETA	T
AD7	-.17007	.05703	-.43243	-2.982
T8	-.59301	.15653	-.55266	-3.788
V	.05906	.01785	.48806	3.308
L	.55465	.24727	.31569	2.243

SUMMARY TABLE

STEP	VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH
1	AD7	.5115	.2616	.2182	6.023	.025	.2616
2	T8	.6560	.4303	.3591	6.043	.011	.1687
3	V	.7986	.6378	.5654	8.805	.001	.2075
4	L	.8565	.7336	.6574	9.637	.001	.0958

AD7 Adjusted Gain subscore 7
T8 Pretest subscore 8
V Cumulative science achievement mean
L Preference for listening to lectures in science classes

Subscore 5 - Food Webs:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 114 in Appendix G.

Subscore 6 - Energy Transfer (Food):

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 115 in Appendix G.

Subscore 7 - Energy Pyramids:

Since no predictor emerged, a table is not included.

Subscore 8 - Nutrient Cycles:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 116 in Appendix G.

Total Score:

The variables in this analysis that had high simple correlations did not emerge in the regression at the .05 level because of the adjustment for distribution and missing data. Free regressions were conducted with these variables and the results are reported in Table 117 in Appendix G.

Regression Summaries of Major Predictors

Comparative summaries of the major predictor of each subscore for the three groups are presented in Tables 93 through 96. Only the major predictor that emerged is specified in these tables. The other variables that accounted significantly for the variance in each of the subscores and/or total score are reported in Tables 18 through 92.

Table 93 indicates that no common background variable for all the groups emerged on any of the subscores or total score for pretest scores. Common patterns for two of the three groups were found in subscore 4 which was the positive perception of learning in science (Q), in subscore 6 was the desire to take additional science classes (MM), and in subscore 8 which was travel distance (TM). The variance explained by the individual variables ranged from 12 percent to 44 percent with a mean of 24 percent.

Table 94 indicates that no common background variable or pretest score for all the groups emerged on any of the subscores or total score for posttest scores. The most consistent predictors were those related to the pretest. If the posttest had not had a low ceiling, the pretest might have been a stronger predictor. Several of the students in each group with high scores on the pretest had little room to increase their scores.

Table 95 reveals a consistent pattern of pretest scores that emerged as major predictors for the individual concept strands on adjusted gain scores. Not only did the pretest scores relate to adjusted gains but consistently did with a high amount of explained variance. The variance accounted for by pretest scores ranged from 33 percent to 98 percent with a mean of 63 percent of the variance. Those students who had lower scores made the greatest gains. This is evidence that the instruction was generally effective.

Table 96 indicates that no common variables emerged on any subscores or total score. However, pretest and adjusted gain scores appeared more frequently than background variables (accounting for a mean variance of 30 percent) and indicated that the students who had scored low on the pretest achieved the greatest gains in the posttest and showed evidence of retention in the delayed testing.

Table 93

BACKGROUND VARIABLES ON PRETEST SCORES

SCORE	GROUP	VARIABLE	MULTR	RSQ	ADJRSQ	
1	one (n=29)	no predictor				
1	two (n=21)	no predictor				
1	three (n=29)	EZ	.3703	.1371	.0863	* -
2	one (n=29)	WV	.3863	.1492	.1177	
2	two (n=21)	UT	.5936	.3523	.2714	*
2	three (n=29)	S	.5163	.2665	.2383	-
3	one (n=29)	C	.3419	.1169	.0617	*
3	two (n=21)	V	.5513	.3039	.2604	-
3	three (n=29)	EZ	.5427	.2945	.2553	-
4	one (n=29)	Q	.4342	.1885	.1158	
4	two (n=21)	PG	.5845	.3416	.3005	
4	three (n=29)	Q	.3837	.1472	.1144	
5	one (n=29)	HO	.4576	.2094	.1801	
5	two (n=21)	no predictor				
5	three (n=29)	MM	.3751	.1407	.1077	
6	one (n=29)	MM	.4213	.1775	.1470	
6	two (n=21)	MM	.6180	.3820	.3476	
6	three (n=29)	LL	.4099	.1681	.1191	* -
7	one (n=29)	CG	.4289	.1840	.1330	*
7	two (n=21)	no predictor				
7	three (n=29)	MM	.6650	.4422	.4094	*
8	one (n=29)	TM	.3870	.1498	.1183	
8	two (n=21)	TM	.4591	.2108	.1669	
8	three (n=29)	C	.5393	.2909	.2492	
T	one (n=29)	Y	.4782	.2288	.1859	
T	two (n=21)	TV	.5322	.2833	.2385	
T	three (n=29)	NG	.6643	.4413	.3947	

* indicates variables not at p <.05 in the regressions
\- indicates a negative relationship

WV Watched science television programs
V Cumulative science achievement mean
Q Positive perception of learning in science
PG Previous science grade mean
HO Hike outdoors
MM Desire to take additional science classes

Table 93 (continued)

TM	Take trips that exceed a distance of 50 miles
Y	Reading as a preferred way of learning science
TV	Watch science television programs (preference)
S	Travel experience (South America)
C	Travel experience (Canada)
NG	Ninth grade science achievement grade
UT	Tenth grade student
CG	Current science achievement grade
LL	Prefer lodge facilities when outdoors

Table 94

BACKGROUND AND PRETEST SCORES ON POSTTEST SCORES

SCORE	GROUP	VARIABLE	MULTR	RSQ	ADJRSQ	
1	one (n=29)	WV	.5441	.2960	.2520	
1	two (n=21)	T8	.6006	.3608	.2808	*
1	three (n=29)	no predictor				
2	one (n=29)	MM	.4266	.1820	.1309	*
2	two (n=21)	no predictor				
2	three (n=29)	no predictor				
3	one (n=29)	CG	.5757	.3314	.2897	
3	two (n=21)	no predictor				
3	three (n=29)	EZ	.5427	.2945	.2530	-
4	one (n=29)	DP	.5000	.2500	.2031	
4	two (n=21)	no predictor				
4	three (n=29)	V	.4881	.2382	.1934	-
5	one (n=29)	M	.5215	.2720	.2265	-
5	two (n=21)	T8	.5530	.3058	.2190	*
5	three (n=29)	TTT	.6096	.3716	.3347	
6	one (n=29)	V	.5518	.3044	.2610	
6	two (n=21)	SX	.6633	.4400	.3700	-
6	three (n=29)	O	.4755	.2261	.1805	
7	one (n=29)	L	.4331	.1876	.1368	*
7	two (n=21)	TTT	.7584	.5722	.5221	
7	three (n=29)	no predictor				
8	one (n=29)	LX	.4880	.2381	.1905	-
8	two (n=21)	EJ	.8065	.6504	.6067	
8	three (n=29)	T6	.4718	.2226	.1255	*
T	one (n=29)	Q	.5983	.3579	.3178	
T	two (n=21)	EJ	.8138	.6623	.6200	
T	three (n=29)	TTT	.5902	.3483	.3100	

* indicates variables not at p <.05 in the regressions
\- indicates a negative relationship

WV Watched science television programs
CG Current cumulative science achievement grade
EZ Eleventh grade science achievement mean
DP Desire to travel to new and different places
TTT Pretest total score
V Cumulative science achievement mean

Table 94 (continued)

SX	Student's sex
EJ	Enjoyment of science classes
M	Travel experience (Mexico)
O	Prefer outdoor investigations in science classes
LX	Prefer lodge facilities when exploring the outdoors
T8	Pretest subscore 8
T6	Pretest subscore 6
MM	Desire to take additional science classes
Q	Positive perception of learning in science
L	Preference for lectures in science classes

Table 95

BACKGROUND AND PRETEST ON ADJUSTED GAIN SCORES

SCORE	GROUP	VARIABLE	MULTR	RSQ	ADJRSQ	
1	one (n=29)	T1	.6969	.4835	.4535	-
1	two (n=21)	T1	.6592	.4345	.3639	-
1	three (n=29)	T1	.7816	.6109	.5880	-
2	one (n=29)	T2	.8085	.6536	.6320	-
2	two (n=21)	T2	.9006	.8111	.7875	-
2	three (n=29)	T2	.9681	.9371	.9334	-
3	one (n=29)	T3	.7525	.5663	.5392	-
3	two (n=21)	T3	.7619	.5805	.5280	-
3	three (n=29)	T3	.8769	.7689	.7553	-
4	one (n=29)	T4	.6314	.3986	.3610	-
4	two (n=21)	T4	.8160	.6659	.6241	-
4	three (n=29)	T4	.9611	.9238	.9193	-
5	one (n=29)	T5	.6954	.4836	.4513	-
5	two (n=21)	T5	.8912	.7942	.7684	-
5	three (n=29)	T5	.8707	.7581	.7438	-
6	one (n=29)	T6	.6505	.4232	.3871	-
6	two (n=21)	TTT	.7943	.6309	.5848	-
6	three (n=29)	T6	.5780	.3341	.2949	-
7	one (n=29)	T7	.5704	.3254	.2832	-
7	two (n=21)	T7	.9917	.9836	.9815	-
7	three (n=29)	T7	.9538	.9098	.9094	-
8	one (n=29)	T8	.5737	.3291	.2871	-
8	two (n=21)	SG	.6438	.4145	.3414	
8	three (n=29)	T8	.8654	.7490	.7342	-
T	one (n=29)	TTT	.6392	.4087	.3717	-
T	two (n=21)	TTT	.8852	.7836	.7566	-
T	three (n=29)	TTT	.9269	.8592	.8509	-

* indicates variables not at p <.05 in the regressions
\- indicates a negative relationship

T1 Pretest subscore 1
T2 Pretest subscore 2
T3 Pretest subscore 3
T4 Pretest subscore 4
T5 Pretest subscore 5
T6 Pretest subscore 6

Table 95 (continued)

T7 Pretest subscore 7
T8 Pretest subscore 8
TTT Pretest total score
SG Seventh grade science achievement grade

Table 96

BACKGROUND, PRETEST, POSTTEST, and ADJUSTED GAIN SCORES ON ADJUSTED RETENTION GAIN SCORES

SCORE	GROUP	VARIABLE	MULTR	RSQ	ADJRSQ	
1	one (n=29)	H	.5167	.2669	.2211	
1	two (n=21)	no predictor				
1	three (n=29)	AD5	.4836	.2339	.1888	
2	one (n=29)	AD2	.6380	.4070	.3700	-
2	two (n=21)	NH	.6892	.4750	.4093	
2	three (n=29)	T3	.4388	.1925	.1450	* -
3	one (n=29)	L	.5132	.2633	.2173	-
3	two (n=21)	no predictor				
3	three (n=29)	T1	.4962	.2462	.2019	-
4	one (n=29)	AD8	.5363	.2877	.2431	
4	two (n=21)	no predictor				
4	three (n=29)	AD7	.5115	.2616	.2182	-
5	one (n=29)	ADT	.5432	.2951	.2510	-
5	two (n=21)	AD5	.6464	.4178	.3450	-
5	three (n=29)	AD6	.4292	.1842	.1362	* -
6	one (n=29)	H	.6374	.4063	.3691	-
6	two (n=21)	S	.8102	.6564	.6134	-
6	three (n=29)	MM	.3588	.1287	.0774	*
7	one (n=29)	T4	.4438	.1969	.1467	* -
7	two (n=21)	AD5	.6896	.4755	.4100	-
7	three (n=29)	no predictor				
8	one (n=29)	AD8	.5360	.2873	.2428	-
8	two (n=21)	PG	.5629	.3169	.2315	* -
8	three (n=29)	T5	.4470	.1998	.1527	* -
T	one (n=29)	ADT	.6644	.4415	.4065	-
T	two (n=21)	no predictor				
T	three (n=29)	MM	.4388	.1925	.1450	*

* indicates variables not at p <.05 in the regressions
\- indicates a negative relationship

AD5 Adjusted Gain score 5
AD2 Adjusted Gain score 2
DP Desire to travel to new and different places
AD3 Adjusted Gain score 3
T1 Pretest subscore 1

Table 96 (continued)

AD8 Adjusted Gain score 8
AD7 Adjusted Gain score 7
H Travel experience (Hawaii or Alaska)
S Travel experience (South America)
ADT Adjusted Gain total score
AD6 Adjusted Gain subscore 6
T3 Pretest subscore 3
T4 Pretest subscore 4
T5 Pretest subscore 5
PG Previous science achievement grade
MM Desire to take additional science classes
NH Like to hike in nature
L Preference for lectures in science classes

PERCENTAGE OF POSSIBLE GAIN AND EMPHASIS RATINGS

Teachers in the study indicated the coverage delivered for each targeted concept area and also recorded the nature of the coverage for each topic on an instructional emphasis form (Appendix C). Tables 97 through 99 summarize the rankings of the three groups. Extensive coverage was represented by a rating of 3; average coverage with a 2; and no coverage by 1. The percentages of possible gain for each subscore area, which was based on pre to posttest changes and the potential for change, are also reported in Tables 97 through 99. The emphasis ratings were compared with the rankings derived from the percentage of possible gain. A discrepancy check was employed with the emphasis ratings and the ranking of gain. The discrepancy scale ranges from 0-17 for groups one and two, and 0-19 for group three (scale is based on the numeric total of the emphasis ratings for each group). The very low discrepancy ratings

indicate that the areas of instructional emphasis did register the highest percentage of student gains. What was emphasized was remembered by the students.

Table 97

PERCENTAGE OF POSSIBLE GAIN AND EMPHASIS RATINGS FOR GROUP ONE (n=29)

SUBSCORE	PERCENTAGE OF POSSIBLE GAIN	RANKING OF GAIN	EMPHASIS RATING	DISCREPANCY SCORE
1	47%	2	2	0
2	50%	3	3	0
3	47%	2	3	-1
4	55%	3	3	0
5	44%	2	2	0
6	37%	1	1	0
7	58%	3	2	-1
8	10%	1	1	0

Table 98

PERCENTAGE OF POSSIBLE GAIN AND EMPHASIS RATINGS FOR GROUP TWO (n=21)

SUBSCORE	PERCENTAGE OF POSSIBLE GAIN	RANKING OF GAIN	EMPHASIS RATING	DISCREPANCY SCORE
1	64%	3	3	0
2	83%	3	3	0
3	56%	2	3	-1
4	64%	2	2	0
5	40%	2	2	0
6	25%	1	1	0
7	80%	3	2	-1
8	20%	1	1	0

Table 99

PERCENTAGE OF POSSIBLE GAIN AND EMPHASIS RATINGS FOR GROUP THREE (n=29)

SUBSCORE	PERCENTAGE OF POSSIBLE GAIN	RANKING OF GAIN	EMPHASIS RATING	DISCREPANCY SCORE
1	77%	3	3	0
2	100%	3	3	0
3	66%	2	3	-1
4	76%	3	3	0
5	69%	2	2	0
6	73%	3	2	-1
7	77%	3	2	-1
8	25%	1	1	0

HYPOTHESES

Data resulting from the analyses of the study were employed in the acceptance or rejection of the null hypotheses. Statements follow for each of the hypotheses.

Hypothesis One

Hypothesis One: There is no significant change in students' understanding of ecological concepts after field instruction strategies.

The Student Ecology Assessment (SEA) instrument was developed as the means of obtaining information on students' understanding of concepts related to ecology and feeding relationships for this study. Items were clustered into eight concept strands related to ecology and were written to address levels of concrete and abstract thinking

as well as higher order reasoning levels. The test was administered prior to the field experience at a pre-trip session and then was re-administered at the conclusion of the field experience while the students were still on-site. The posttest gains made by students of all three groups were statistically significant ($p < .001$) (Appendix H). The means of the subscores of the posttest in each of the eight concept strands were all higher than the means of the pre-test subscores. Based on a comparison of pretest to post-test results of the SEA, Hypothesis One was rejected.

Hypothesis Two

Hypothesis Two: There is no significant decrease in retention of concepts evidenced after the field exposure.

The Student Ecology Assessment (SEA) instrument was administered to the three groups of students four weeks after the field instruction program at the groups' final posttrip session. The average mean of the posttest for all groups was 34.46 and the average mean of the retention test was 33.95, thus indicating that the students did retain the concepts. The subscore means of the retention test indicate gains in areas of instructional emphasis and decreases in the areas of no or low emphasis. Based on the retention test results of the SEA instrument, the null hypothesis was accepted.

Hypothesis Three

Hypothesis Three: There are no significant relationships between background variables and gains in understanding of concepts.

The student background and attitude form was designed to obtain information on students': science academic standing; sex; grade level; science course background; science interests; science extracurricular involvements; perceptions of learnings; learning style preference; and travel and outdoor experience. Frequencies were examined for each of the variables and only the items that a majority of the students did not respond to, or did not provide data for, were eliminated from analysis. These included: ninth grade item; the names of the science courses from seventh grade to the current class; and travel to Australia and Africa. These items received no responses. The background data were then entered into multiple regression analyses with the results from the pretest, posttest, retention test, adjusted gain, and the retention gain subscores and total scores. In all of the regressions, no consistent pattern of background variables emerged for the three groups. In some cases common patterns for two of the three groups were found in a limited number of subscores but no background variables were consistently present. The variance explained by these individual variables ranged from 12 per-

cent to 44 percent with a mean of 24 percent. The pretest scores emerged as predictors consistently with the adjusted gain scores. The variance accounted for by pretest scores ranged from 32 percent to 98 percent of the variance (with a mean of 63 percent) with the adjusted gain scores. Based on the regression results, the null hypothesis was accepted.

Hypothesis Four

Hypothesis Four states that there is no significant relationship between instructional emphasis and students' science achievement gains.

Teachers indicated the coverage given for each specified concept area and also recorded the nature of the coverage for each topic on an instructional emphasis form. This form was completed during the pretrip, trip, and posttrip sessions. Information was also requested on the time and emphasis devoted to administrative, procedural, and instructional tasks. Students reported their perceptions of the emphasis given to each targeted concept area on a similar form. The responses were congruent. The emphasis ratings were then compared with the percentages of possible gain for each of the subscore areas. The percentage of possible gain was calculated based on the pre to posttest changes and the potential for gain. A discrepancy check was employed with the emphasis ratings and the ranking of

gain. Based on a 0 to 19 discrepancy scale, the groups only registered a 2 or 3 total point discrepancy betweem the ranking of gain and emphasis rating. These results indicate that the areas of instructional emphasis evidenced the highest percentage of student gain. Based on this analysis, the null hypothesis was rejected.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

In this chapter a summary of the study is provided, conclusions are drawn, and recommendations for further study and practice are made.

SUMMARY

This study was designed to examine the nature of ideas and beliefs which students hold about specific scientific concepts and to investigate modes of instruction that would effectively help them gain an accurate understanding of their world.

The Student Ecology Assessment (SEA) instrument was developed as the mean of obtaining information on students' understanding of concepts related to ecology and feeding relationships. Items were based on the theoretical framework outlined in the meaningful learning approach to instruction. Related concepts were carefully selected and validated through concept mapping and a literature survey of curricular materials and programs on ecology and marine studies. The instrument was revised three times as a

result of the responses, comments, and correlational analyses of four groups of secondary science students. The instrument was developed as a mastery device to complement the program's instructional emphasis. A student background and attitude form was also developed and administered. Variables such as science interest, science involvements, sex, academic achievement, learning style preference, and travel and outdoor experience were considered and examined in the regression analyses.

An experiential marine science field program served as the learning strategy. Three self-selected groups of secondary level students participated in the study. Two of the groups were from a high school in Columbus, Ohio and one group was from Fairfax, Virginia. The field component of the program for all three groups occurred from 27 December 1986 to 3 January 1987. Two programs were conducted at sites on Andros Island, Bahamas and one program took place on Grand Cayman Island. Exploratory activities were provided during the excursion. Instruction on ecology comprised one part of the total field program and was monitored in terms of instructional emphasis and time allocated to activities addressing the specified concepts.

Students responded to The Student Ecology Assessment (SEA) prior to, during, and four weeks after the field program. Data obtained from the SEA were subjected to item

analysis evaluation. Further analyses of data from the SEA instrument, student background and attitude form, and instructional emphasis form included: frequency distributions; correlational analyses; and multiple regression analyses. Additional computations were also performed and included: adjusted gain scores; t test calculations; and percentages of possible gain.

Overall, the three groups of students evidenced significant gains in posttest total scores on the SEA instrument ($p.<.001$). Results on the retention test also indicated that the concepts addressed in the instrument were retained by the students.

Student subscores for each of the eight major concept strands were then analyzed separately. Subscore results for the post and retention tests were standardized into adjusted gain scores for further analyses to account for the ceiling effect that was evident in the pretest results. A series of regressions were conducted using subscore and total score data from each group's pretest, posttest, retention test, adjusted gain, and retention adjusted gain results. Background data and instructional emphasis ratings were included in the analyses.

Generally, from all the regressions performed (n=162), no significant pattern of predictor background variables was apparent other than student interest in science, inter-

est in taking more science classes, and positive perception of learning with the pretest results. The strongest predictor of student scores that emerged consistently in all groups was previous knowledge, as indicated by pretest and adjusted gain scores. Generally, students who had the lowest pretest scores showed the greatest gains.

Gains in students' scores in the eight concept strands were related to the instructional emphasis given to those areas. In each of the three groups, the topics that were targeted for emphasis revealed the highest percentages of possible gain.

The effectiveness of the field instructional program was apparent in that specific concepts that were targeted for emphasis were learned and retained by the students. Student responses to the SEA instrument in posttest and retention test phases support this premise. The mastery approach to learning in a field setting proved to assist in the improvement of students' understanding of the selected concepts.

MAJOR CONCLUSIONS

The findings of this study allow the following conclusions to be drawn:

1. Abstract concepts related to ecology and feeding relationships can be taught and learned effectively through an experiential field instruction program.

2. Improvement in students' understanding of specific ecological concepts occurred after involvement in a field-based learning program.
3. Biological concepts related to ecology that were taught in a field setting were retained by the students.
4. Students who scored low on the pretest achieved the greatest gains on the posttest.
5. Prior knowledge as indicated by pretest and adjusted gain scores served as a predictor of science achievement on The Student Ecology Assessment (SEA) instrument.
6. Background variables such as grade level, sex, learning style, and travel and outdoor experience generally were not significantly related to students' science achievement scores as measured by The Student Ecology Assessment (SEA) instrument.
7. Students' positive perception of science learning, enjoyment of science classes, and desire to take additional courses in science were related to selected subscore results on the pretest of The Student Ecology Assessment (SEA) instrument.
8. Teachers and students expressed similar perceptions of the instructional emphasis given to the targeted concepts.

9. The students' greatest gains in achievement and in retention occurred with the concepts that received the greatest instructional emphasis.

RECOMMENDATIONS FOR FURTHER RESEARCH

Based on the findings and on the insights derived from this study, it is hoped that examination of the effectiveness of the field instruction strategy in the sciences would include and/or extend to:

1. Investigations of the effectiveness of field instruction strategies with other complex ecological concepts such as: adaptation; community relationships; population dynamics; behavioral relationships; and cyclic patterns.
2. Replication studies involving other age groups of students, especially middle school age youth.
3. Comparisons with other variants of field experiences, specifically focusing on excursions of shorter duration and/or to more localized sites.
4. Comparisons with other instructional approaches and teaching methods, specifically vicarious field experiences such as computer simulations and/or media presentations.
5. Comparisons with non-structured approaches to field experiences.

6. Investigations of the effect of teacher characteristics on program effectiveness.
7. Investigations of the impact of field experiences on concept learning with special populations of students, specifically children who are educational disadvantaged and/or emotionally troubled.
8. Investigations of the effectiveness of the mastery approach in a field setting with emphasis on skill development, specifically hypothesis formation and testing.
9. Investigations of the relationship of instructional emphasis and mastery learning in settings other than the field environment.

RECOMMENDATIONS FOR PRACTICE

1. It is suggested that school districts provide opportunities for all students to participate in field-based activities for the purpose of mastery learning.
2. It is suggested that a hierarchial approach be incorportated in the testing of students' understandings of concepts, with attention being directed to the inclusion and arrangement of familiar/unfamiliar and concrete/formal items in testing instruments.
3. It is suggested that attention be given to the congruence of program emphasis, instruction, and testing in science teaching.

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Appendix A

STUDENT ECOLOGY ASSESSMENT (SEA) INSTRUMENT

NAME_____
CODE_____

CIRCLE THE ANSWER THAT YOU THINK IS THE BEST RESPONSE FOR EACH ITEM.

Use these illustrations for questions 1-2.

1. Which set is comprised of only animals?
   a. II, IV, VI
   b. III, V, VI
   c. II, IV, VII
   d. II, III, VI

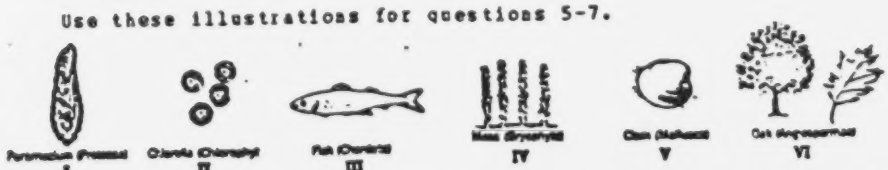
2. Which set would be found in or near an aquatic environment?
   a. IV, V, VII
   b. V, VI, VII
   c. a and b
   d. none of the above

Use these illustrations for questions 3-4.

3. Which set is comprised of only animals?
   a. I, III, V
   b. III, IV, VI
   c. II, IV, V
   d. none of the above

4. Which set would be found in a tidal pool?
   a. I, V, VI
   b. II, IV, V
   c. I, II, III
   d. IV, V, VI

Use these illustrations for questions 5-7.



5. Why would I and II be considered different from the others?
   a. They are unicellular
   b. They are multicellular
   c. They are naturally green
   d. They have a nucleus

6. If II, IV and VI are classified together, it would be because they
   a. can photosynthesize
   b. lack conducting tissue
   c. do not move
   d. are multicellular

7. If III is classified in its own group, it's because it has
   a. the ability to move
   b. form
   c. definite nuclei
   d. a backbone

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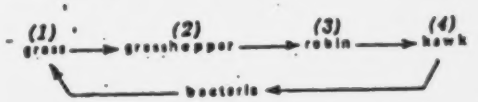
8. All consumer organisms
   a. really act as decomposers
   b. need other sources of food
   c. eat very selectively
   d. are large in size

9. A producer/consumer pair that you would find in the upper region of an intertidal pool would be
   a. algae and starfish
   b. snails and barnacles
   c. sponges and sea grasses
   d. algae and barnacles

10. A producer/consumer pair of the deep open ocean would be
   a. sea grasses and corals
   b. corals and damsel fish
   c. algae and corals
   d. algae and ghost crabs

11. The greatest diversity of life occurs
   a. along the beach
   b. in the deepest ocean depths
   c. surface to 100 ft. in the sea
   d. in tidal pools

12-15. This is an example of a food chain. Identify the organisms below.



This is an example of a *four-step food chain.*

12. Producers_____
13. Primary consumers_____
14. Secondary consumers_____
15. Decomposers_____

16-19. The following four questions are based on this situation...In a certain region of the reef, the scales of damselfish are being parasitized by worms (ugh). Assume that the 'scale-worms' can only live on damselfish. The principle fod in the diet of damselfish is algae.

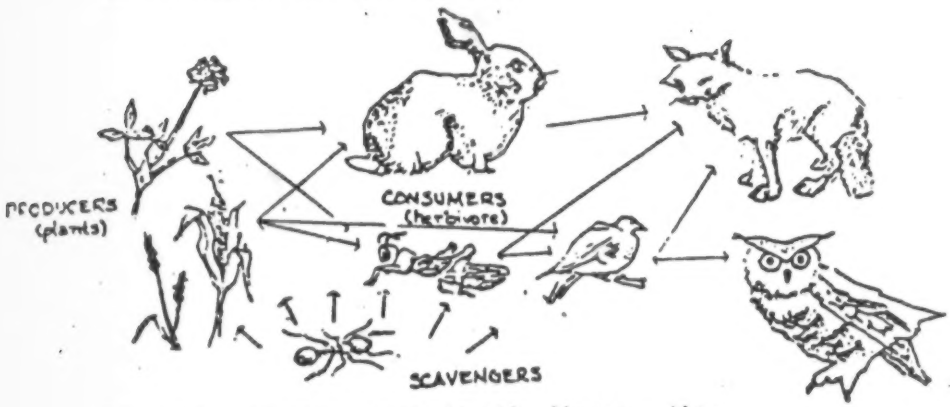
16. What is the food chain in this case?
   a. Algae---damselfish---scale-worm
   b. Scale-worm---damselfish---algae
   c. Sun---damselfish---scale-worm
   d. Damselfish---algae---scale-worm

17. If the population of scale-worms becomes so large that the scales of many fish are damaged. What effect on the food chain could occur?
   a. Algae will decrease
   b. Algae will increase
   c. Fish will increase
   d. All populations will increase

18. A snail which feeds on scale-worms enters. If the snails thrive, what would be the effect on the food chain?
   a. Fish will increase
   b. Algae will increase
   c. Scale-worms will increase
   d. All except snails will increase

19. If scale-worms were destroyed, then you could expect that
   a. fish will die out
   b. more algae would be eaten
   c. snails will die out
   d. snails will increase

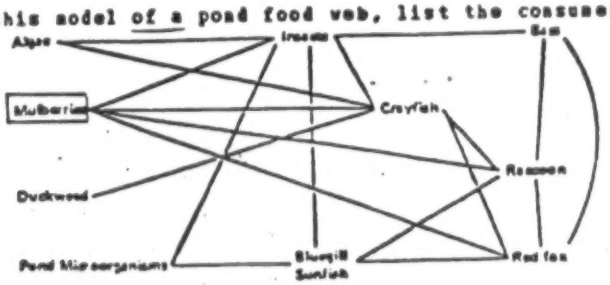
20-21. Observe the food web below



20. If humans were placed in this diagram, they
    a. would not fit in any of the food chains
    b. could be a second order consumer
    c. would be at the head of every food chain
    d. none of the above

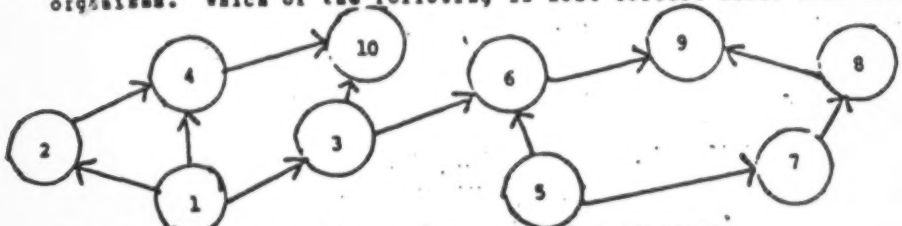
21. The diagram shows that
    a. the fox can feed on more than one organism
    b. scavengers just do not belong
    c. second order consumers only feed on herbivores
    d. all of the above

22-24. In this model of a pond food web, list the consumers of MULBERRIES



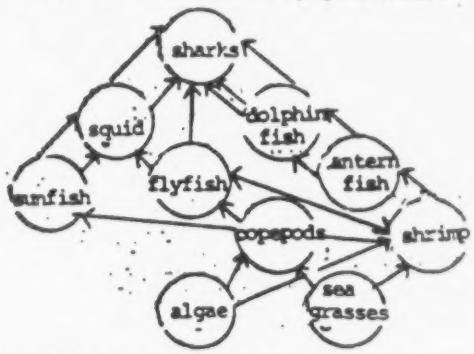
22. _____
23. _____
24. _____

25. Below is an imaginary food web. The number in the circles represent organisms. Which of the following is most correct about this web?



    a. 6 and 7 are both first and second order consumers
    b. 9 and 10 can be on the fourth trophic level
    c. 5 and 7 are on the first trophic level
    d. 2 and 7 are on different trophic levels

26-29. Refer to this chart and the key for the following questions.

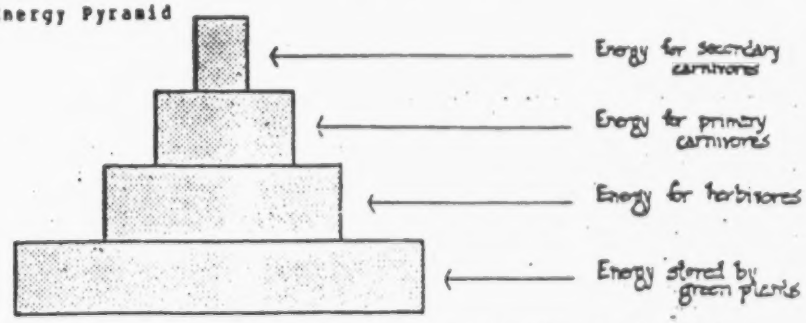


KEY
1. This statement is accurate according to the chart
2. This statement is incorrect according to the chart
3. This goes beyond information in the chart

26. Plants are the foundation in this system._____
27. Copepods are harmful and should be killed._____
28. Parasites contribute to food losses._____
29. Algae would not be affected by squid and flyfish._____

30. If humans were to spear the very best lobsters from the reef, it is possible that the lobster population as a whole may be
a. weakened
b. strengthened
c. unaffected
d. I don't know

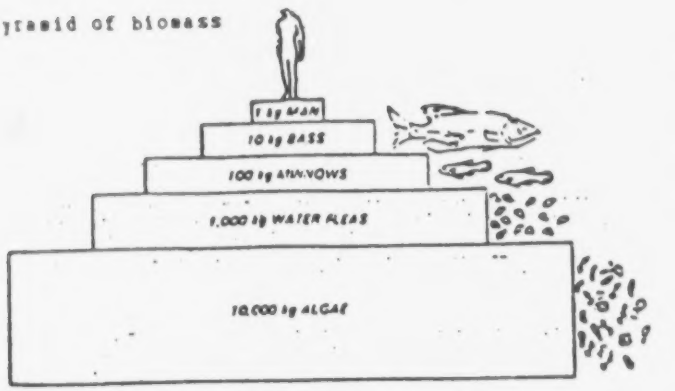
31-32. Energy Pyramid



31. The energy represented at each level in the diagram indicates
a. energy needs of organisms
b. energy spent by organisms
c. amount of transfered energy
d. energy benefits are equal

32. As energy flows through a food chain
a. the total amount goes directly to the next level
b. a proportion is lost as heat
c. only producers and consumers benefit
d. energy is accumulated and increased

33. Pyramid of biomass

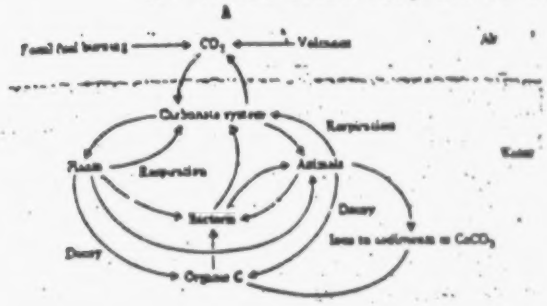


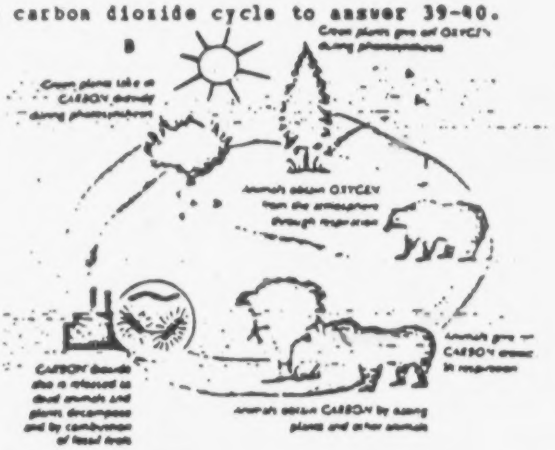
33. The pyramid of biomass diagram
    a. should always have plants at the base of it
    b. has mass decreasing from bottom to top
    c. is similiar to the energy pyramid
    d. all of the above

34-38. In this example of a food pyramid, place the following at the correct level: ALGAE; TUNA; ZOOPLANKTON; KILLER WHALES; SHRIMP

34. _____
35. _____
36. _____
37. _____
38. _____

39-40. Use these diagrams of the carbon dioxide cycle to answer 39-40.




B
Green plants take in CARBON dioxide during photosynthesis
Green plants give out OXYGEN during photosynthesis
Animals obtain OXYGEN from the atmosphere through respiration
CARBON dioxide also is released as dead animals and plants decompose and by combustion of fossil fuels
Animals obtain CARBON by eating plants and other animals
Animals give out CARBON dioxide in respiration

39. Animals obtain their supply of carbon from
    a. the atmosphere
    b. decomposers
    c. plants, other animals they eat
    d. the compound, carbon dioxide

40. Diagrams A and B indicate that
    a. only plants and animals contribute to carbonate systems
    b. through respiration animals obtain carbon dioxide
    c. bacteria assist in releasing carbon dioxide
    d. animals both take in and release carbon dioxide and oxygen

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Appendix B

STUDENT BACKGROUND AND ATTITUDE FORM

This form will be coded so that you will remain anonymous to the person who is scoring this form. Answer as honestly and completely as you can to each of the following questions. Thank-you.

1. Indicate the grade that you are presently in
   a. 9th c. 11th
   b. 10th d. 12th

2. Indicate your sex
   a. female b. male

3. In general, do you enjoy science classes?
   a. always c. sometimes e. never
   b. usually d. rarely

4. If you are taking science this year, circle your current grade.
   a. A c. C e. F
   b. B d. D

5. What grade did you generally get in previous years science classes?
   a. A c. C e. F
   b. B d. D

6. List the science course that you had at each grade and the final grade
   a. 7th_____ _____ d. 10th_____ _____
   b. 8th_____ _____ e. 11th_____ _____
   c. 9th_____ _____ f. 12th_____ _____

7. In general, how much have you learned in science classes?
   a. a great amount c. very little
   b. an average amount d. nothing

8. Are you planning to taking more courses in science?
   a. definitely yes c. uncertain e. definitely no
   b. mostly yes d. mostly no

9. How many trips in a year do you take that are more than 3 days long?
   a. more than 6 c. 1-2
   b. 3-6 d. I don't

10. How many trips do you take in a year that are more than 50 miles away?
   a. more than 6 c. 1-2
   b. 3-6 d. I don't

11.Circle the places that you have visited.

a. Canada	d. Asia	g. South America
b. Mexico	e. Europe	h. Australia
c. Caribbean	f. Africa	i. Hawaii or Alaska

12.How often do you generally camp overnight in one year?

a. more than 6 times	c. 1-2 times
b. 3-6 times	d. I don't

13.Where do you prefer to stay when you're exploring the outdoors?

a. in a tent	c. at a lodge or cabin
b. in a travel trailer	d. in a motel

14.Where do you generally stay when you're exploring the outdoors?

a. in a tent	c. at a lodge or cabin
b. in a travel trailer	d. in a motel

15.Do you like to travel to new and different places?

a. definitely yes	c. it doesn't matter
b. later maybe	d. not at all

16.List your preferred modes of learning (state 1st, 2nd, 3rd choice)

a. listening to lectures___	d. working in outdoor activities___
b. doing lab activities___	e. reading by myself_____
c. working in a group_____	

17.Circle the activities that you like to do.

a. science fairs	d. read science magazines or books
b. nature hikes	e. watch science TV programs
c. science clubs	f. environmental action projects

18.Circle the activities that you have already done.

a. science fair projects	d. read science magazines or books
b. hiked outdoors	e. watched science TV programs
c. attended science clubs	f. environmental action projects

☺☺☺HAVE A GREAT TRIP☺☺☺

Appendix C

INSTRUCTIONAL EMPHASIS PERCEPTION FORM

SCHOOL_____ TEACHER_____

PLEASE CIRCLE THE CATEGORY THAT MOST CLEARLY DESCRIBES THE COVERAGE RECEIVED BY EACH TOPIC IN YOUR PRE-TRIP SESSIONS. INDICATE THE NATURE OF THE COVERAGE WHEN APPLICABLE (e.g. slides, lecture, activity etc.)

	NONE (1)	AVERAGE (2)	EXTENSIVE (3)	EXAMPLE
PLANT and ANIMAL CHARACTERISTICS	(1)	(2)	(3)	
PLANT and ANIMAL IDENTIFICATION	(1)	(2)	(3)	
PLANT and ANIMAL HABITATS	(1)	(2)	(3)	
FEEDING RELATIONSHIPS	(1)	(2)	(3)	
FOOD CHAINS	(1)	(2)	(3)	
FOOD WEBS	(1)	(2)	(3)	
ENERGY TRANSFER (FOOD)	(1)	(2)	(3)	
ENERGY PYRAMIDS	(1)	(2)	(3)	
NUTRIENT CYCLES (CARBON)	(1)	(2)	(3)	

LIST THE THREE TOPICS THAT RECEIVED THE MOST TIME AND EMPHASIS

1. _____

2. _____

3. _____

WHAT OTHER SCIENCE CONCEPTS ARE COVERED. INDICATE THE COVERAGE.

	NONE (1)	AVERAGE (2)	EXTENSIVE (3)
1. _____	(1)	(2)	(3)
2. _____	(1)	(2)	(3)
3. _____	(1)	(2)	(3)

RATE THE TIME DEVOTED TO THE FOLLOWING TASKS IN YOUR PRE-TRIP SESSIONS.

1. ADMINISTRATIVE (fores, reports)	(1)	(2)	(3)
2. PROCEDURAL (schedules, rules)	(1)	(2)	(3)
3. INSTRUCTIONAL (science-related)	(1)	(2)	(3)

PLEASE CIRCLE THE CATEGORY THAT MOST CLEARLY DESCRIBES THE COVERAGE RECEIVED BY EACH TOPIC DURING THE FIELD EXPERIENCE. INDICATE THE NATURE OF THE COVERAGE WHEN APPLICABLE. (e.g. activity, experiment etc.)

	NONE (1)	AVERAGE (2)	EXTENSIVE (3)	EXAMPLE
PLANT and ANIMAL CHARACTERISTICS	(1)	(2)	(3)	
PLANT and ANIMAL IDENTIFICATION	(1)	(2)	(3)	
PLANT and ANIMAL HABITATS	(1)	(2)	(3)	
FEEDING RELATIONSHIPS	(1)	(2)	(3)	
FOOD CHAINS	(1)	(2)	(3)	
FOOD WEBS	(1)	(2)	(3)	
ENERGY TRANSFER (FOOD)	(1)	(2)	(3)	
ENERGY PYRAMIDS	(1)	(2)	(3)	
NUTRIENT CYCLES (CARBON)	(1)	(2)	(3)	

WHICH OF THE ABOVE TOPICS WERE ADDRESSED THE MOST ON THE TRIP

1. _____
2. _____
3. _____

WHAT OTHER TOPICS WERE COVERED AND TO WHAT EXTENT?

1. _____	(1)	(2)	(3)
2. _____	(1)	(2)	(3)
3. _____	(1)	(2)	(3)

PLEASE CIRCLE THE CATEGORY THAT MOST CLEARLY DESCRIBES THE COVERAGE RECEIVED BY EACH TOPIC IN YOUR POST-TRIP SESSIONS. INDICATE THE NATURE OF THE COVERAGE WHEN APPLICABLE (e.g. slides, lecture, activity etc.)

	NONE (1)	AVERAGE (2)	EXTENSIVE (3)	EXAMPLE
PLANT and ANIMAL CHARACTERISTICS	(1)	(2)	(3)	
PLANT and ANIMAL IDENTIFICATION	(1)	(2)	(3)	
PLANT and ANIMAL HABITATS	(1)	(2)	(3)	
FEEDING RELATIONSHIPS	(1)	(2)	(3)	
FOOD CHAINS	(1)	(2)	(3)	
FOOD WEBS	(1)	(2)	(3)	
ENERGY TRANSFER (FOOD)	(1)	(2)	(3)	
ENERGY PYRAMIDS	(1)	(2)	(3)	
NUTRIENT CYCLES (CARBON)	(1)	(2)	(3)	

LIST THE THREE TOPICS THAT RECEIVED THE MOST TIME AND EMPHASIS

1. _____
2. _____
3. _____

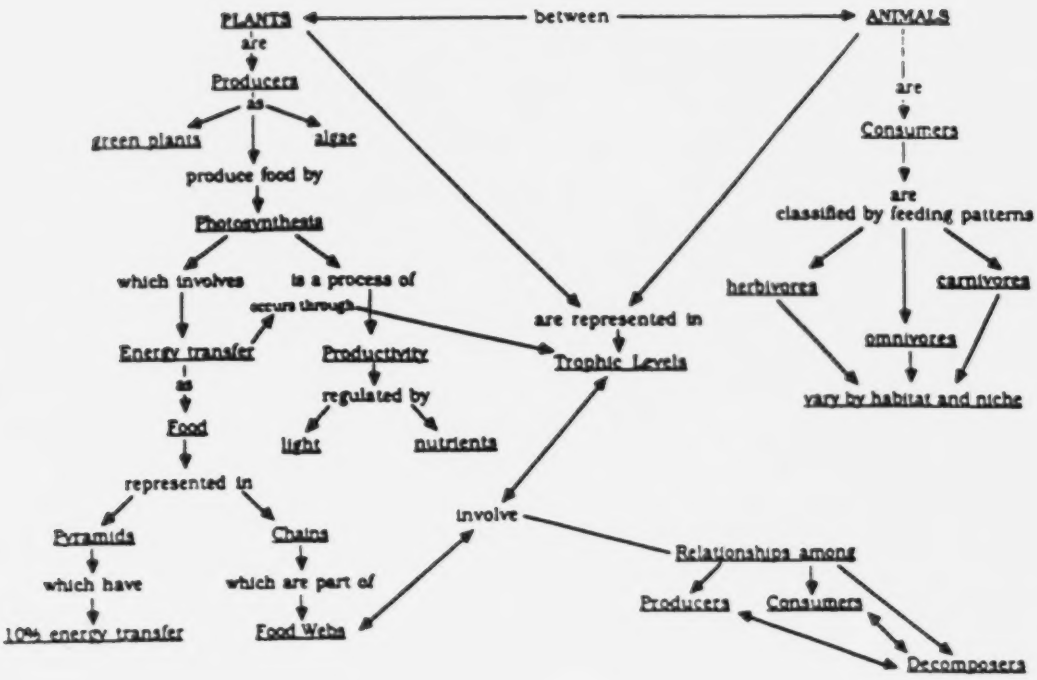
GENERALLY, MOST TIME IN POST-TRIP SESSIONS ARE DEVOTED TO

1. _____
2. _____
3. _____

Appendix D

CONCEPT MAP

FEEDING RELATIONSHIPS



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Appendix E

BACKGROUND AND ATTITUDE VARIABLE LABELS

UT	10th grade student
UE	11th grade student
GW	12th grade student
SX	Sex of student
EJ	Enjoyment of science classes
CG	Current science achievement grade
PG	Previous science achievement grade mean
SG	Seventh grade science achievement grade mean
EG	Eighth grade science achievement grade mean
NG	Ninth grade science achievement grade mean
TG	Tenth grade science achievement grade mean
EZ	Eleventh grade science achievement grade mean
TT	Total years of science instruction (from 7-12 grades)
V	Cumulative science achievement mean
Q	Positive perception of degree of learning in science
MM	Desire to take additional science classes
TR	Trips taken yearly that exceed a 3 day duration
TM	Trips taken yearly that exceed a distance of 50 miles
C	Travel to Canada
M	Travel to Mexico
R	Travel to the Caribbean
A	Travel to Asia
E	Travel to Europe
F	Travel to Africa
S	Travel to South America
U	Travel to Australia
H	Travel to Hawaii or Alaska
T	Total countries visited
CA	Camping trips taken in a year
LZ	Prefer tents while exploring the outdoors
LY	Prefer travel trailers while exploring the outdoors
LX	Prefer lodge facilities while exploring the outdoors
LW	Prefer a motel when exploring the outdoors
LV	Reside in a tent when exploring the outdoors
LU	Reside in travel trailers when exploring the outdoors
LL	Reside in lodges when exploring the outdoors
LS	Reside in motels when exploring the outdoors
DP	Desire to travel to new and different places
L	Prefer lectures in science classes
D	Prefer laboratory activities in science classes

W	Prefer to work in groups in science classes
O	Prefer outdoor investigations in science classes
Y	Prefer reading in science classes
SF	Like science fairs
NH	Like nature hikes
CC	Like science clubs
RM	Like to read science magazines or books
TV	Like to watch science television programs
EE	Like to do environmental actions projects
GTG	Total of science-related activities like to do
FP	Completed science fair projects
HO	Hiked outdoors
AT	Participated in science clubs
MB	Read science magazines or books
WV	Watched science television programs
EP	Participated in environmental action projects
OTO	Total of science-related activities completed

Appendix F

CONCEPT VARIABLE LABELS

T1	Pretest subscore 1
T2	Pretest subscore 2
T3	Pretest subscore 3
T4	Pretest subscore 4
T5	Pretest subscore 5
T6	Pretest subscore 6
T7	Pretest subscore 7
T8	Pretest subscore 8
TTT	Pretest total score
PST1	Posttest subscore 1
PST2	Posttest subscore 2
PST3	Posttest subscore 3
PST4	Posttest subscore 4
PST5	Posttest subscore 5
PST6	Posttest subscore 6
PST7	Posttest subscore 7
PST8	Posttest subscore 8
PSTT	Posttest total score
AD1	Adjusted gain subscore 1
AD2	Adjusted gain subscore 2
AD3	Adjusted gain subscore 3
AD4	Adjusted gain subscore 4
AD5	Adjusted gain subscore 5
AD6	Adjusted gain subscore 6
AD7	Adjusted gain subscore 7
AD8	Adjusted gain subscore 8
ADT	Adjusted gain total score
RT1	Retention subscore 1
RT2	Retention subscore 2
RT3	Retention subscore 3
RT4	Retention subscore 4
RT5	Retention subscore 5
RT6	Retention subscore 6
RT7	Retention subscore 7
RT8	Retention subscore 8
RTTT	Retention total score
RA1	Retention adjusted gain subscore 1
RA2	Retention adjusted gain subscore 2
RA3	Retention adjusted gain subscore 3
RA4	Retention adjusted gain subscore 4

RA5	Retention adjusted gain subscore 5
RA6	Retention adjusted gain subscore 6
RA7	Retention adjusted gain subscore 7
RA8	Retention adjusted gain subscore 8
RAT	Retention adjusted gain total score

Appendix G

REGRESSION TABLES NOT FOUND IN THE TEXT

GROUP ONE

Table 100

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 3 FOR GROUP ONE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
C	.3419	.1169	.0617	2.118	.165	.1169	.3419
H	.4480	.2007	.0942	1.884	.186	.0839	-.3222

C Travel experience to Canada
H Travel experience to Hawaii and/or Alaska

Table 101

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 7 FOR GROUP ONE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
CG	.4289	.1840	.1330	3.608	.076	.1840	.4289
DP	.5613	.3150	.2237	3.449	.059	.1310	.4250

CG Current science achievement grade
DP Desire to travel to new and different places

Table 102

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 2 FOR GROUP ONE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
MM	.4266	.1820	.1309	3.559	.077	.1820	.4266

MM Desire to take additional science classes

Table 103

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 7 FOR GROUP ONE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
L	.4331	.1876	.1368	3.695	.073	.1876	-.4331

L Prefer listening to lectures in science classes

Table 104

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 7 FOR GROUP ONE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
T4	.4438	.1969	.1467	3.923	.065	.1969	-.4438
ADT	.5985	.3581	.2726	4.185	.036	.1612	-.2861
H	.7439	.5534	.4577	5.782	.009	.1952	.2025
TTT	.8015	.6423	.5323	5.837	.006	.0890	-.2743

T4 Pretest subscore 4
ADT Adjusted Gain Total score
H Travel experience to Hawaii and/or Alaska
TTT Pretest Total score

GROUP TWO

Table 105

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 2 FOR GROUP TWO (n=21)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
UT	.5936	.3523	.2714	4.352	.070	.3523	.5936

UT Tenth grade students

Table 106

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 1 FOR GROUP TWO (n=21)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
T8	.6006	.3608	.2808	4.515	.066	.3608	.6066
SG	.7454	.5556	.4286	4.376	.059	.1949	-.5627

T8 Pretest subscore 8
SG Seventh grade science achievement mean

Table 107

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 5 FOR GROUP TWO (n=21)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
T8	.5530	.3058	.2190	3.524	.097	.3058	.5530
TTT	.7323	.5363	.4038	4.047	.068	.2305	-.1995
EJ	.8361	.6991	.5487	4.647	.052	.1628	.4873

T8 Pretest subscore 8
TTT Pretest Total score
EJ Enjoyment of science classes

Table 108

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 8 FOR GROUP TWO (n=21)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
PG	.5629	.3169	.2315	3.711	.090	.3169	-.5629
T1	.6984	.4877	.3413	3.332	.096	.1708	-.4531
AD5	.8242	.6793	.5190	4.237	.063	.1916	.2277

PG Previous science achievement mean
T1 Pretest subscore 1
AD5 Adjusted Gain subscore 5

GROUP THREE

Table 109

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 1 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
EZ	.3703	.1371	.0863	2.701	.119	.1371	-.3703
CG	.5208	.2713	.1802	2.978	.080	.1342	.2032

EZ Eleventh grade science achievement grade
CG Current science achievement grade

Table 110

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 6 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
LL	.4099	.1681	.1191	3.434	.081	.1681	-.4099

LL Reside in lodges when exploring the outdoors

Table 111

REGRESSION OF BACKGROUND VARIABLES ON PRETEST SUBSCORE 7 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
MM	.6650	.4422	.4094	13.479	.002	.4422	.6650
M	.7389	.5460	.4893	9.622	.002	.1038	.3826
SF	.7958	.6333	.5599	8.634	.001	.0872	-.2381

MM Desire to take additional science classes
M Travel experience to Mexico
SF Like to be involved in science fairs

Table 112

REGRESSION OF BACKGROUND AND PRETEST SCORES ON POSTTEST SUBSCORE 8 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
T6	.4718	.2226	.1255	2.291	.133	.1040	.2226

T6 Pretest subscore 6

Table 113

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 2 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
T3	.4388	.1925	.1450	4.053	.060	.1925	-.4388
EZ	.6151	.3783	.3006	4.868	.022	.1858	.4113
AD6	.7822	.6118	.5341	7.880	.002	.2335	.1799

T3 Pretest subscore 3
EZ Eleventh grade science achievement grade
AD6 Adjusted Gain subscore 6

Table 114

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 5 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
AD6	.4292	.1842	.1362	3.838	.067	.1842	-.4292
AD7	.5955	.3546	.2739	4.395	.030	.1704	.3378
TT	.7254	.5262	.4315	5.554	.009	.1716	.2943

AD6 Adjusted Gain subscore 6
AD7 Adjusted Gain subscore 7
TT Total years of science instruction (7-12 grades)

Table 115

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 6 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
MM	.3588	.1287	.0774	2.511	.131	.1287	.3588
CG	.5088	.2589	.1663	2.795	.091	.1302	-.2065

MM Desire to take additional science classes
CG Current science achievement grade

Table 116

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION SUBSCORE 8 FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
T5	.4470	.1998	.1527	4.245	.055	.1998	-.4470

T5 Pretest subscore 5

Table 117

REGRESSION OF BACKGROUND, PRETEST, POSTTEST, ADJUSTED GAIN SCORES ON ADJUSTED RETENTION TOTAL SCORE FOR GROUP THREE (n=29)

VARIABLE	MULTR	RSQ	ADJRSQ	F(EQN)	SIGF	RSQCH	CORREL
MM	.4388	.1925	.1450	4.054	.060	.1925	.4388
LX	.6185	.3826	.3054	4.957	.021	.1900	-.3965
T5	.7355	.5410	.4492	5.894	.007	.1584	-.1966

MM Desire to take additional science classes
LX Prefer lodge facilities when exploring the outdoors
T5 Pretest subscore 5

Appendix H

PRETEST AND POSTTEST T TEST RESULTS

Table 118

PRETEST AND POSTTEST T TEST RESULTS

GROUP	n	PRETEST MEAN	PRETEST S.D.	POSTTEST MEAN	POSTTEST S.D.	T
1	29	25.86	4.30	32.45	3.99	5.99*
2	21	28.71	4.35	35.19	2.70	4.35*
3	29	26.75	5.36	35.90	1.91	6.72*

* $p < .001$